J. Cochran

ORIGINAL

QUALITY ASSURANCE/QUALITY CONTROL PLAN
FOR
REMEDIAL INVESTIGATION AND FEASIBILITY STUDIES
AT THE
KOPPERS SOUTH CAVALCADE SITE
HOUSTON, TEXAS

001368

Koppers Company, Inc.
Pittsburgh, Pennsylvania 15219

KOPPERS

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May, 1985

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QUALITY ASSURANCE/QUALITY CONTROL PLAN
REMEDIAL ACTION AND FEASIBILITY STUDIES
KOPPERS SOUTH CAVALCADE SITE
HOUSTON, TEXAS

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Approved by ______________________________ Date ____________
Koppers Manager, Previously Operated Properties

Approved by ______________________________ Date ____________
Project Manager

Approved by ______________________________ Date ____________
EPA QA/QC Officer

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REMEDIAL INVESTIGATION AND FEASIBILITY STUDIES
KOPPERS SOUTH CAVALCADE SITE
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1.0 PROJECT DESCRIPTION

Koppers Company, Inc. (Koppers) has consented to perform the remedial investigation and feasibility studies for the South Cavalcade site. The overall Work Plan describes the project in detail. A brief project background and statement of objectives follow.

1.1 Historical Background

The South Cavalcade site is currently bounded by the Houston Belt Terminal railroad tracks to the east, Cavalcade Road to the north, Missouri Pacific railroad tracks to the west, and Collingsworth Road to the south. The site currently consists of approximately 45 acres on a parcel of land 1-1/2 miles southwest of the intersection between Loop 610 and U.S. Route 59 (Eastex Freeway).

The majority of the site area has formerly been used as a production facility for creosote and other wood preservative products. From 1911 to 1939 the plant was operated by the National Lumber and Creosoting Company. This operation consisted of a production facility on the southwest corner of the site and "dripping" and drying areas toward the center and northern areas of the site. The National Lumber and Creosoting Company operation was purchased by Koppers Company in 1940. In addition to wood preserving operation, a coal tar distillation process facility was also constructed and operated in the southeast corner of the site. Ponds, tanks, and lagoons existed on the site. The facility was closed by Koppers in 1962. All plant buildings were removed and the site area was covered

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with soil. Currently, three palletized trucking firms have operations located within the site boundaries; Meridian Transport Company (Merchants Fast Motorized Lines) in the central and southwestern corners of the site, Palletized Trucking Inc. in the southeastern corner of the site and Transcon Lines on the northern portion of the site. AJF Leasing also operates within the property boundry on the northeast corner of the site. Both AJF and Transcon operations are situated on a portion of the site owned by the Baptist Foundation of Texas.

In early 1980's the Harris County Metropolitan Transit Authority (MTA) became interested in the site for a combined railyard, shop, and station for a proposed light rail transit system. During routine geotechnical investigations by McClelland Engineers Inc. (MEI) for preliminary design purposes, several localized areas were found to be contaminated with creosote waste products. Camp Dresser & McKee Inc. (CDM) was then retained to perform a contaminant survey and to develop remedial measures that would mitigate the contamination and allow use of the land by MTA. During the course of CDM's work, MTA revised their construction plans to largely exclude the area north of Cavalcade Street. CDM's report, "Cavalcade Contaminant Survey", dated July 11, 1983, documented the presence of soil and shallow groundwater contaminated with creosote waste products and heavy metals. Failure of bond issue in May 1983 resulted in the termination of CDM's work prior to selection of an appropriate remedial alternative and site remediation.

After the bond failure, the site fell under the jurisdiction of the Texas Department of Water Resources (TDWR). Shortly thereafter, the site was handed over to the US EPA and was placed on the National Priority List (NPL).

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1.2 Project Objectives

The purpose of the project is to assess the nature, degree, and extent of contamination resulting from past activities at the site, to evaluate the hazard to human health and the environment, and to identify and evaluate the merits of alternative remedial solutions. These objectives can be efficiently met by completing the following tasks:

- Characterizing the site in terms of wastes present; lateral and vertical extent of contamination in surface waters, ground waters, sediments and soils; rate and direction of waste migration; target receptors (population at risk, threatened resources, and sensitive ecosystems); and site geology and surface water/ground water hydrology.

- Developing and evaluating alternative remedial measures considering economic feasibility, technological feasibility, environmental impacts, regulatory constraints, and timeliness of completion; and offering recommendations regarding the most cost effective remedial alternatives.

This Quality Assurance/Quality Control Plan has been prepared to document the measures that will be undertaken by Koppers and its subcontractors to assure that the work performed will be of proper quality to accomplish project objectives and will be responsive to the requirements of the USEPA. This plan describes the Quality Assurance (QA) organization, procedures, documentation requirements, acceptance criteria, and audit and corrective action procedures for the South Cavalcade remedial investigation and feasibility study.

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2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Figure 2-1 shows the project organization chart indicating individual assignments. For purposes of this project, the personnel of Koppers and subcontractors will work within a single organization. All participants in the organization are directly subject to the requirements of this Quality Assurance/Quality Control Plan.

2.1 Authority and Responsibilities

2.1.1 Manager, Previously Operated Properties

This corporate level manager will be the prime point of contact with the USEPA and will act as the corporate interface for the project team. Other duties include disseminating all project-related information to and from the USEPA.

2.1.2 Project Manager

The Project Manager will have responsibility for technical, financial, and scheduling matters. Other duties, as necessary, will include:

- Subcontractor procurement
- Assignment of duties of the Project Staff and orientation of the Staff to the needs and requirements of the project
- Approval of project-specific procedures and internally prepared plans, drawings, and reports
- Serve as liaison between the Project Staff and other internal groups, such as the laboratories

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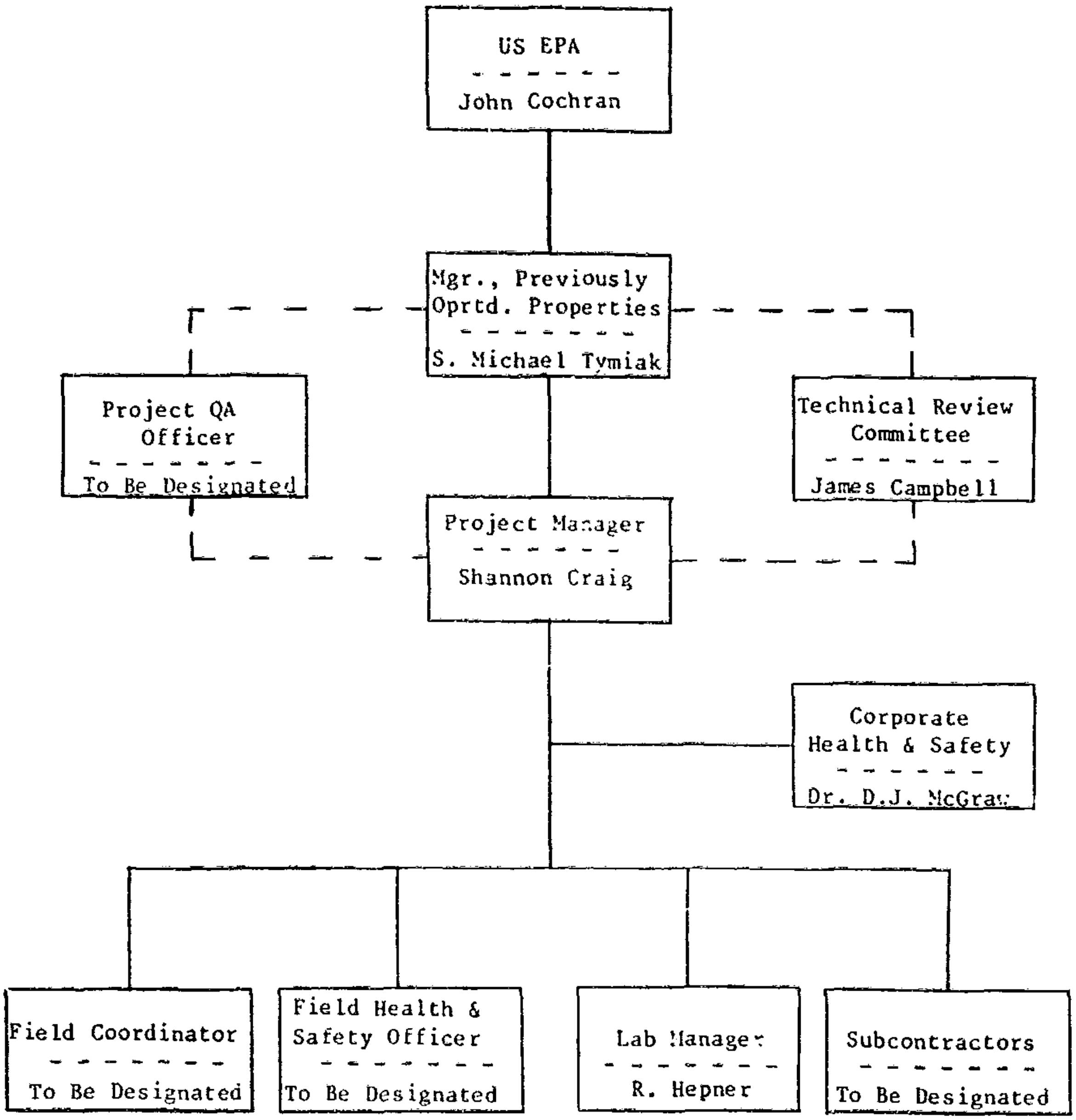
Figure 2-1

PROJECT ORGANIZATION



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- Serve as the "collection point" for Project Staff reporting of nonconformances and changes in project documents and activities

- Determination of the effect of nonconformance and changes on the project and the appropriateness for reporting such items to the USEPA, in accordance with the terms of the Administrative order and consent signed by Koppers and the USEPA.

2.1.3 Technical Review Committee

The Technical Review Committee will, as requested, provide the Project Manager and Manager of Previously Operated Properties with technical input and guidance during all phases of the project. This committee will be headed by a Chairman.

2.1.4 Project Quality Assurance Officer (QAO)

Responsibilities of the Project Quality Assurance Officer, as appropriate, include:

- Administration of the Project Quality Assurance/Quality Control Program
- Review and approval of this plan
- Management and review of quality assurance activities
- Notification tc personnel of nonconformance and changes in quality assurance procedures

For this project, the QAO reports indirectly to the Manager, Previously Operated Properties, and, works independent of the Project Manager.

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2.1.5 Corporate Health and Safety Manager

The Corporate Health and Safety Manager will assume responsibility for approving and implementing a Health and Safety Plan which satisfies state and federal regulations and is consistent with the site's nature. Additional details on the Health and Safety Program are presented in the Koppers South Cavalcade Health and Safety Plan.

2.1.6 Field Coordinator

The Field Coordinator will be responsible for field activities including those of subcontractors such as drillers. As Field Coordinator he will also be responsible for subcontractor compliance with applicable requirements of this Quality Assurance/Quality Control Plan and for communication of field activity information to the USEPA. The Field Coordinator will assit the Project Manager in day-to-day management of the project. The field coordinator will also be responsible for issuance and tracking of measurement and test equipment, and will be responsible for the proper labeling, handling, storage, shipping, and chain of custody procedures used at the time of sampling.

2.1.7 Laboratory Manager

The Laboratory Manager will be responsible for the project laboratories (i.e.; chemical and geotechnical) implementing the requirements of this QA/QC Plan. The manager's responsibilities will, as appropriate, include:

- General supervision of laboratories
- Collaboration with the Project Group in establishing sampling and testing programs
- Schedule and execution of testing programs
- Serve as liaison between the Laboratory Staffs and other groups

- o Serve as the "collection point" for Laboratory Staff reporting of nonconformances and changes in laboratory activities
- o Notification of the Laboratory and Quality Assurance Groups of specific laboratory nonconformances and changes
- o Maintenance of laboratory data and checkprints while the project, or testing phase, is in progress
- o Release of testing data and results
- o Calibration of equipment
- o Storage of samples.

2.1.8 Field Health and Safety Officer

The Field Health and Safety Officer will be responsible for the day-to-day adherence to the Health and Safety plan during site activities. Specifically his responsibilities include, in part:

- o issuance of personal protective equipment
- o maintaining and using field air monitoring equipment
- o designating protection levels and deciding protection level upgrades

2.2 Project Communications

Project-related materials which are incoming to Koppers in the form of correspondence, sketches, logs, authorizations, or other information will be routed to the Project Manager after the original is marked with the date received. The Project Manager will then determine which personnel will review the materials and route the materials accordingly.

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As soon as practical, incoming correspondence originals will be placed in the project central file. If the correspondence is required by the project personnel for reference, a copy should be made rather than holding the original. Correspondence which is of importance to the QA/QC Plan will be routed to the project QAO.

Project-related materials transmitted external to Koppers including correspondence, reports, drawings, and sketches will be appropriately reviewed, approved, and if necessary signed prior to transmittal. Project outgoing correspondence will, as a minimum, be signed by the Project Manager, or a key level individual assigned this responsibility by the Project Manager. If joint signatures are desirable, the originator of the correspondence, when different from management, may also sign. Quality assurance correspondence will be signed by the Project QAO.

Outgoing project correspondence and reports should be read by the Project Manager prior to mailing. The office copy of project correspondence should bear routing information and be routed to the Project QAO, if judged appropriate by the Project Manager.

To facilitate communications, progress meetings will be held on site as needed; with the Project Manager, Field Coordinator, and key staff members in attendance. Meeting notes will be subsequently issued to appropriate staff members.

On or before the 10th of each month, the Project Manager will summarize project progress. Copies of such reports will be distributed to the USEPA representative and the Project QAO.

Communications relative to the project which are initiated by third parties (e.g.; media, interested individuals and groups) will be referred directly to designated USEPA representative(s) without comment.

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3.0 QUALITY ASSURANCE OBJECTIVES

The purpose of the Project Quality Assurance/Quality Control Program is to facilitate the implementation of regulatory requirements and to provide internal means for control and review so that the work performed by Koppers and its subcontractors is of the highest professional standards.

Project objectives are as follows:

- Scientific data generated will be of sufficient or greater quality to stand up to scientific and legal scrutiny.
- Data will be gathered or developed in accordance with procedures appropriate for the intended use of the data.
- Data will be of known or acceptable precision, accuracy, representativeness, completeness, and comparability within the limits of the project.
- Adequate funding will be provided to the extent appropriate to support an acceptable level of quality assurance.

The quality of the measurement data can be defined in terms of the following elements:

- Completeness - the adequacy in quantity of valid measurements to prevent misinterpretation and to answer all important questions.
- Representativeness - the extent to which discrete measurements accurately describe the greater picture which they are intended to represent. Good representativeness is

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achieved through careful, informed selection of sampling sites, drilling sites, drilling depths and analytical parameters.

- Accuracy and Precision - the agreement between a measurement and the true value and the degree of variability in this agreement, respectively. Accuracy and precision of data collected in the investigation will depend upon the measurement standards used and the meticulous, competent use of them by qualified personnel.

- Comparability - the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability among measurements through the use of standard procedures and standard field data sheets.

- Traceability -the extent to which data can be substantiated by hard-copy documentation. Traceability documentation exists in two essential forms: that which links quantitation to authoritative standards, and that which explicitly describes the history of each sample from collection to analysis.

The fundamental mechanisms that will be employed to achieve these quality goals can be categorized as prevention, assessment and correction, as follows:

1) Prevention of defects in the quality through planning and design, documented instructions and procedures, and careful selection and training of skilled, qualified personnel;

2) Quality assessment through a program of regular audits and inspections to supplement continual informal review;

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3) Permanent correction of conditions adverse to quality through a closed-loop corrective action system.

The Koppers South Cavalcade Quality Assurance/Quality Control Plan has been prepared in direct response to these goals. This plan describes the Quality Assurance Program to be implemented and the quality control procedures to be followed by Koppers and Koppers' subcontractors during the course of the remedial investigation and feasibility studies for the South Cavalcade site.

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4.0 QUALITY ASSURANCE/QUALITY CONTROL SITE EXPLORATION AND SAMPLING

This section describes specific activities aimed at the prevention and early detection of circumstances adversely affecting quality in each of the measurement tasks of the field investigation.

4.1 Training

All Koppers and subcontractor personnel working on the South Cavalcade investigation will be properly-trained, qualified individuals. Prior to commencement of field work, all field personnel will be given instruction specific to the South Cavalcade investigation, covering the following areas:

- Organization and lines of communication and authority
- Description of the South Cavalcade site
- Overview of the Work Plan and QA Plan
- Documentation Requirements
- Personal Protection
- Decontamination Procedures
- Emergency Procedures

Training of field personr l will be provided by the Field Coordinator or a qualified designee.

4.2 Quality Control of Subcontractors

Subcontractor quality control is that system of activities which ensures that products or services obtained from subcontractors fulfill the needs of the project, as defined by contractual, regulatory, or other requirements. Subcontractor quality control begins with subcontractor procurement.

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For the South Cavalcade investigation, the responsibility for procurement of subcontractors rests with the Project Manager. The Project Manager or a designee will complete the following steps in the procurement process, with the assistance of Corporate Contracts and/or Purchasing:

- Obtain competitive bids from qualified bidders, which should include bidder's qualifications in terms of personnel and physical resources, Quality Assurance Program and Health and Safety Program,
- Conduct or have conducted pre-qualification audits, if appropriate,
- Select successful bidder on the basis of price and qualifications.

On-going observation and monitoring of subcontractor performance during the field investigation will be the responsibility of the Field Coordinator. Periodic quality control inspections of each subcontractor will be performed by the field coordinator or a designee to evaluate adherence to the project Work Plan, QA Plan and Health and Safety Plan. Inspection will include (as appropriate):

- Type and condition of equipment
- Calibration procedures
- Personnel qualifications
- Documentation

Results of the inspections will be recorded in the Field Log and reported on a regular basis to the Project Manager.

4.3 Field Log

An integral part of Quality Assurance/Quality Control of field activities will be the maintaining of a field log. Information obtained from site exploration activities will be recorded and documented.

Members of the Project Staff working in field operations will keep a field log of their project activities. Items to be included in the field log, as appropriate, are:

- Field activity subject
- General work activity
- Unusual events
- Visitors on site
- Subcontractor progress or problems
- Communication with USEPA or others
- Koppers personnel on site
- Sampling locations.

Appropriate test data forms will also be prepared. They will include, as appropriate, the test location (e.g.; boring, well, depth, sampling station, elevation, and field coordinates) and applicable analysis to be conducted. All requested information will be addressed. If not applicable, requested information should be designated as such.

Field records will be collected and maintained by the Field Coordinator until completion of the field program or program phase, or until they are submitted to the project central file. During the performance of a field program, it is anticipated that a copy of the field records be periodically made and sent to the Project Manager. These copies can provide adequate documentation of work activities should the originals be destroyed, lost, or stolen.

4.4 Document Control

The QA Plan and all standard Operating Procedures (SOP) will have the following information on each page:

- o Page Number
- o Section number
- o Revision number
- o Revision date

When the QA Plan is revised, the affected pages are reissued to all personnel with updated revision numbers (as appropriate) and dates. Issuance of revisions is accompanied by explicit instructions as to which documents or portions of documents have become obsolete.

4.5 Project Sampling Plan

A detailed Project Sampling and Analytical Plan has been prepared to document the scope and methodology of exploration and sampling activities at the South Cavalcade site. This section of the Quality Assurance/Quality Control Plan will refer extensively to procedures and requirements included in the Sampling and Analytical Plan.

The sampling program is based on the project objectives coupled with a review of existing data for the site vicinity. The program includes the following elements:

- o Site Reconniassance
  - Inventory of Existing Water Wells
  - Geophysical Survey
- o Surface Sediment Sampling
- o Surficial Soil Sampling
- o Shallow Soil Borings
- o Deep Soil Borings
- o Shallow Monitor Wells
- o Deep Monitor Wells
- o Storm Water Runoff/Surface Water Sampling
- o Ground Water Sampling
- o Air Sampling and Monitoring
- o Nonsoil Materials Sampling

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4.5.1 Sample Control Procedures and Chain of Custody

Successful analysis depends on the capability to produce valid data and to demonstrate such validity. In addition to proper sample collection, preservation, storage and handling, it is necessary to follow proper procedures for sample identification and chain-of-custody. The procedures specified herein are those used by the Office of Enforcement, U.S. Environmental Protection Agency as of October, 1980.

4.5.2 Sample Identification

All samples will be containerized in sample containers that have been cleaned, treated with preservative (as appropriate) and pre-labeled by the laboratory. The labels on containers provided by the laboratory will state the type and amount of preservative (if any) and the sample type for which the container is intended. As samples are collected and containerized, the following information will be added to each label:

- o Project Name
- o Sample Number
- o Station Location - Description of place where sample was taken (e.g., the well or boring site identification).
- o Date - A six-digit number indicating the year, month and day of collection.
- o Time - A four-digit number indicating the military time of collection.
- o Sampler - Initials of person collecting the sample.
- o Remarks - Any pertinent observations or further sample description.

After collection, identification, and preservation, the sample is maintained under chain-of-custody procedures discussed below.

4.5.3 Chain-of-Custody Procedures

Chain-of-custody procedures are intended to document sample possession from the time of collection to disposal, in accordance with federal guidelines. To maintain and document permanently sample possession, chain-of-custody procedures are followed: A sample is under custody if:

- o It is in your possession, or
- o It is in your view, after being in your possession, or
- o It was in your possession and then you locked it up to prevent tampering, or
- o It is in a designated secure area.

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FIELD CUSTODY PROCEDURES

1. Collect only that number of samples which provides a good representation of the media being sampled. To the extent possible, the quantity and types of samples and sample locations have been determined and are outlined in the Sampling and Analytical Plan. As few people as possible should handle samples.

2. The Field Coordinator is responsible for the care and custody of the samples collected until they are transferred or dispatched properly.

3. The Field Coordinator determines whether proper custody procedures were followed during the field work and decides if additional samples are required.

4. Prior to commencement of sampling, the Field Coordinator will instruct all sampling personnel in the chain-of-custody procedures, if it is necessary.

TRANSFER OF CUSTODY AND SHIPMENT

1. Samples are accompanied by a Chain-of-Custody Record (Figure 4-1) from the time they are collected until analysis is performed. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst at the laboratory.

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CHAIN OF CUSTODY RECORD

PLANT CODE	PROJECT NAME						NUMBER OF CONTAINERS						REMARKS OR OBSERVATIONS
SAMPLERS *(Signature)*													
STA. NO.	DATE	TIME	COMP.	GRAB	WELL	STATION LOCATION							

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks	

Distribution: Original accompanies shipment; Copy to Coordinator Field Files.

Figure 4-1 Chain-of-Custody Record

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2. Minimum information recorded on the chain-of-custody record in addition to the signatures and dates of all custodians will include:

   - Sampling site identification
   - Sampling date and time
   - Identification of sample collector
   - Sample identification
   - Sample description (type and quantity)
   - Analyses to be performed.

3. Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate custody record accompanying each shipment. Shipping containers will be sealed with fiber tape for shipment to the laboratory. The method of shipment, courier name(s) and other pertinent information are entered in the "Remarks" box.

4. Whenever samples are split with another laboratory, it is noted in the "Remarks" section. The note indicates with whom the samples are being split and is signed by both the sampler and recipient. If either party refuses a split sample, this will be noted and signed by both parties. The person relinquishing the samples to the facility or agency should request the signature of a representative of the appropriate party, acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Remarks" space. When appropriate, as in the case where the representative is unavailable, the custody record should contain a statement that the samples were delivered to the designated location at the designated time.

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5. Each shipment will be accompanied by the Chain-of-Custody Record identifying its contents. The original record will accompany the shipment, and a copy will be retained by the sampling supervisor.

6. The receiving laboratory's sample log should indicate the condition of samples as received, and should explicitly state whether the chain-of-custody seal (fiber tape) is intact.

7. The receiving laboratory should retain a copy of each chain-of-custody record, with the shipper's waybill or airbill attached.

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4.6 Soil Boring and Monitoring Well Construction

Table 4-1 is a list of SOP applicable to the project. The SOP are contained in Appendix A. Standard procedures for soil borings and monitoring well construction are given in SOP's 7115 and 7220, respectively.

Drilling and sampling equipment, monitoring well construction materials and decontamination procedures are given in the Sampling and Analytical Plan.

A geologist or other qualified individual will complete a detailed record of each boring (Form No. 1911, SOP 7115), and will log all site activities during the subsurface investigation in the field log. Items to be noted in the field log include:

QUALITY ASSURANCE/QUALITY CONTROL PLAN

TABLE 4-1

STANDARD OPERATING PROCEDURE LIST

Number	Title
2005	Numerical Analysis and Peer Review
7115	Subsurface Soil Sampling
7120	Surface Water Sampling
7130	Groundwater Sample Collection from Monitoring Wells
7220	Monitoring Well Construction
7315	Operation/Calibration of HNu Photoionization Analyzer
7510	Packaging and Shipment of Samples
7600	Decontamination of Equipment
7710	Borehole Pressure Testing

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- o Date, time of each entry and initials of person making the entry,
- o Work activities underway
- o Unusual events
- o Visitors to the site
- o Koppers personnel on site
- o Subcontractor progress/problems
- o Communications with USEPA

The geologist or other qualified person will be responsible for monitoring the drilling subcontractor's performance, as described in Section 4.2 of this plan.

Borehole permeability testing will be performed on selected wells following the sampling round. This testing will be performed and documented under the direction of the geologist, in accordance with SOP 7710.

4.7 Sampling/Sample Preservation/Storage

Ground water samples will be collected in accordance with SOP 7130, Ground Water Sample Collection from Monitoring Wells. With field samples, a minimum of one blank sample (deionized water) will accompany each sampling kit from the laboratory to the field and back, so that any contamination of samples can be detected.

The importance of proper sampling cannot be over-emphasized. Even though the well or boring being sampled may be correctly located and constructed, special precautions will be taken to ensure that the sample taken is representative of the ground water or sub-surface soil at that location and that the sample is neither altered nor contaminated by the sampling and handling procedure.

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4.7.1 Sample Containers for Chemical Analysis

The required sample containers, filling instructions and preservation procedures are listed in Tables 4-2 and 4-3. Sample preservatives will be placed in the containers by the Laboratory, prior to issuance of the sample kits.

Containers for organics analyses will be prepared in the laboratory as follows:

1. Wash with hot detergent water.
2. Rinse thoroughly with tap water followed by three or more rinses with organic-free water.
3. Rinse with pesticide quality redistilled acetone, followed by equivalent quality methylene chloride.
4. Allow to air dry in a contaminant free area.
5. Cap and liners must be washed and rinsed also.

Containers will be stored and shipped with the Teflon-lined caps securely fastened.

4.7.2 Sample Collection

Soil Samples for Chemical Analysis

Collect and containerize the samples in the appropriate containers promptly upon opening the split-spoon samples. Fill each jar or vial as completely as possible without allowing sample material to interfere with the airtight seal. Promptly cap each filled container and make sure it is well sealed. Label each sample in accordance with Section 4.5.2 of this plan. Store samples in boxes with dividers to protect samples from breakage.

TABLE 4-2

SAMPLE CONTAINERS, PRESERVATION, HOLDING TIMES –
GROUNDWATER AND SURFACE WATER

for presence of residual chlorine

Measurable	Container/Volume	Preservation	Holding Time
Base/Neutral Extractables	One 1-liter glass bottles, teflon-lined caps	Cool, $4^{\circ}C$; protect from light	7 days (until extraction)
Volatile Organics	Two 40-ml VOA vials, teflon-lined caps	Cool, 4°; protect from light	14 days
Acid Extractables	One 1-liter glass bottles, teflon-lined caps	Cool, $4^{\circ}C$; protect from light	7 days (until extraction)
Cyanide	One 1-liter Cubitainer	Cool, $4^{\circ}C$; NaOH to pH 12;	14 days
Priority Pollutant Metals	One 1-liter Cubitainer	Chromium VI → cool 4°C mercury → HNO_3 to pH < 2; filter samples before containerizing	24 hours 28 days. 6 months
Iron	One 1-liter Cubitainer	HNO_3 to pH < 2, filter samples before containerizing	6 months
Nitrate	One 1-liter Cubitainer	Cool, $4^{\circ}C$	48 hours
Pesticides and PCB'S	One 1-liter glass bottle teflon-lined caps	Cool, $4^{\circ}C$; protect from light if extracted ≤ 72 hrs ? for aldrin → add .008% $Na_2S_2O_3$	7 days

TABLE 4-3

SAMPLE CONTAINERS, PRESERVATION, HOLDING TIMES -
SOILS AND SEDIMENTS

Measurable	Container/Volume	Preservation	Holding Time
Acid & Base/Neutral Fraction Mix	Four 1-liter wide mouth glass jars, teflon-lined caps	Cool 4°C; protect from light	14 days (until extraction)
Volatile Organics	Two 40ml VOA vials teflon-lined caps	Cool, 4°C; protect from light	14 days
Acid Extractables	One 1-liter wide mouth glass jar	Cool, 4°C; protect from light	14 days (until extraction)
Cyanide	1-liter wide mouth glass jar	Cool, 4°C	14 days
Arsenic	One 8 ounce wide mouth glass jar	None	6 months
Priority Pollutant Metals	One 8 ounce wide mouth glass jar	None	6 months

Soil Samples for Geotechnical Analysis

Collect soil samples from the split spoon using procedures as noted above. Each jar label should contain sample identification and depth, so that each sample can be related to corresponding notes on the boring log. The sample boxes should contain dividers to protect samples from breakage. Sample boxes should be taped shut in the field, sealed with fiber tape and labeled with the project name.

If the jar samples are to be temporarily stored on site, they will be protected from the weather, including excessive heat and freezing. Indoor storage will be employed, where possible. Undisturbed soil samples (Shelby tube) will be kept in the tubes. At least one-half inch of soil will be cleared from each end of the tube and the ends of the sample squared off. Usually, the top of the sample will contain drill cuttings and these must be removed prior to sealing. Under certain circumstances, a tube may be allowed to drain prior to the sealing process. Tubes will be sealed at both ends with parafin wax (or equivalent). If they are to be shipped, pack the samples in wooden boxes (Section 4.7.4). Label the samples as described in Section 4.5.2; include the depth interval. All samples should be logged in the Field Log. Sample numbers should be noted, at corresponding depth on the boring log.

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Water Samples for Chemical Analyses

Ground water samples will be collected from the monitoring wells in accordance with SOP 7130. To ensure representative samples, pH readings will be taken repeatedly during well purging. Samples will be collected after pH readings have stabilized.

Samples collected for analysis of dissolved inorganics will be filtered in the field using a 0.45-micron filter element in a Millipore (or equivalent) filtration apparatus equipped with a hand or electrical vacuum pump. If field filtration or organic samples is also necessary or desirable, use a glass membrane filter. Filtered samples must be transferred immediately to the appropriate containers. Label the sample in accordance with Section 4.5.2 of this Plan. Record the sampling event in the Field Log.

4.7.3 Decontamination

All sampling tools and equipment (including filtration apparatus) will be decontamiated before use and after each sampling event, in accordance with SOP 7600, Decontamination.

4.7.4 Sample Preservation, Shipment and Storage

Samples for Chemical Analysis

Samples will be iced or refrigerated at 4°C from the time of collection until laboratory analysis. If residual chlorine is known or suspected to be present, 80 mg of sodium thiosulfate per liter of sample will be added. Preservation procedures for all organics and inorganics samples are summarized in Tables 4-2 and 4-3.

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Samples will be protected from breakage and shipped in coolers. Blue ice or equivalent, will be used to maintain a temperature of 4°C. A carrier will be selected which will insure delivery at the laboratory within 24-36 hours after collection. For out-of-town shipment of samples, air express overnight service will be considered. Records of all sample shipments will be maintained by the Field Coordinator. Copies of chain-of-custody records and shipper's airbill or waybill will be retained.

Samples for Geotechnical Analysis

Samples will be stored in such a way as to protect from temperature extremes, and water damage to the box.

In terms of transporting undisturbed soil samples to the laboratory, every effort will be made to prevent disruption. If possible, samples will be hand-carried. Their in-situ orientation should be maintained. If shipped, they will be tightly packed in wooden boxes with packing material and/or dividers to prevent movement. Any evidence of disruption of undisturbed soil samples should be brought to the attention of the Project Manager.

4.8 Field Measurement Equipment

The field measurement equipment to be used in the South Cavalcade site investigation is listed in Table 4-4, along with summarized quality control procedures. Detailed operation and calibration procedures are contained in the appropriate SOPs (Appendix A).

001404

TABLE 4-4

FIELD MEASUREMENT EQUIPMENT QUALITY CONTROL

Device	Calibration	Routine Check: Method	Frequency	Control Limits
pH Meter	Standardize in two or more standard buffer solutions	Calibration check-analyze standard buffer solution	1/10 Samples	To be determined
		Analyze replicates	1/10 Samples	To be determined
Conductivity Meter	Standardize using two or more KCL solutions	Calibration check-analyze standard KCL solution	1/10 Samples	To be determined
Organic Vapor Analyzer	Standardize, daily, using clean air and compressed gas standard (Isobutylene)	Span check with compressed gas standard	Once each day of use	To be determined

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Documented and approved procedures will be used for calibrating measuring and test equipment. Whenever possible, widely accepted procedures, such as those published by the ASTM or EPA, or procedures provided by manufacturers, will be adopted.

Calibrated equipment will be uniquely identified by using either the manufacturer's serial number, Koppers identification number, or other means. This identification, along with a label indicating when the next calibration is due, will be attached to the equipment. If this is not possible, records traceable to the equipment will be readily available for reference.

It will be the responsibility of all personnel to check the calibration status from the due date labels or records prior to using the equipment.

Measuring and test equipment will be calibrated at prescribed intervals and/or prior to use. Frequency will be based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience. Sensitive equipment to be used for site characterization will be calibrated or checked prior to use on this project.

Equipment that fails calibration or becomes inoperable during use will be removed from service and segregated to prevent inadvertent use, or will be tagged to indicate it is out of calibration. Such equipment will be repaired and satisfactorily recalibrated to the satisfaction of the Laboratory Manager or Field Coordinator as appropriate. Equipment that cannot be repaired will be replaced.

The Field Coordinator will delegate responsibility for control and calibration of field measurement equipment, as appropriate. Each sampling team shall have one member who is responsible for the measurement equipment used for characterization of samples.

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5.0 ANALYTICAL LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

5.1 Chemical Analysis

5.1.1 Log-in and Storage of Samples

All samples submitted to the laboratory for chemical analysis will be accompanied by chain-of-custody documentation. The laboratory sample custodian will complete each chain-of-custody record by signing and dating it as custodian. All samples will be carefully inspected for:

- Intact air-tight seal, where necessary
- Evidence of damage
- Completeness of accompanying records

No samples will be accepted by the receiving laboratory personnel unless they are properly labeled and sealed.

After inspection, each sample will be logged in and assigned a unique laboratory sample identification number. Information entered in the logbook for each sample should include:

- Field sample identification number
- Laboratory sample identification number
- Date received
- Project name and number
- Collection date
- Sample type

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- o Condition of sample (from inspection)
- o Analyses sought,
- o Assigned storage location.

Samples will be refrigerated in a secure location at 4°C until analyzed.

5.1.2 Analytical Quality Control

Chemical analyses will be performed by Koppers Company, Inc. in Pittsburgh, Pennsylvania, and subcontract laboratories using the sample preparation and analytical methods listed in Table 5-1. An overview of the laboratory quality control/quality assurance program will be provided before analytical work begins.

5.2 Geotechnical Analysis

Samples for geotechnical analysis will be inspected and logged in according to applicable parts of 5.1.1. Any evidence of damage (i.e., broken jars or disruption of undisturbed soil samples) will be promptly reported to the Project Manager. Samples will be stored in a secure cabinet, and protected from temperature extremes until they are analyzed.

Geotechnical analyses will be performed in accordance with current revisions of the appropriate ASTM procedures (Table 5-1). Only qualified analysts who have demonstrated proficiency at these procedures will perform the tests. All measurement equipment used in the testing will be calibrated to NBS or equivalent standards, and documentation of traceability to those standards will be maintained.

001408

TABLE 5-1

ANALYTICAL METHODS

Parameter	Method	Method No.	Expected Detection Limit
Water Samples			
Volatile Organics	Gas Chromatography - Mass Spectrometry	624	10-100 mg/l
Acid Extractables	Gas Chromatography - Mass Spectrometry	625	10-50 mg/l
Base-Neutral Extractables	Gas Chromatography - Mass Spectrometry	625	10-50 mg/l
Priority Pollutant Metals	Digestion	200.2	(metal specific)
Cyanide	Titrimetric-Spectophotometric	335.2	0.005 mg/l
Iron	AA/Direct Aspiration	236.1	0.1 mg/l
Nitrate	Colorimetric	352.1	0.1 mg/l
Pesticides and PCB's	Gas Chromatography	608	0.1 to 1.0 mg/l
pH	Electrometric	150.1	0.01 pH unit
Temperature	Thermometric	170.1	
Conductivity	Conductimetric	120.1	1 m mho/cm
Dissolved Oxygen	Electrometric	360.1/360.2	0.1 mg/l
Sediment & Soils Samples			
Volatile Organics	Gas Chromatography - Mass Spectrometry	8240	1.0 mg/kg

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TABLE 5-1 (Cont'd)

ANALYTICAL METHODS

Parameter	Method	Method No.	Expected Detection Limit
Acid Extractables	Gas Chromatography - Mass Spectrometry	8250	1.0 mg/kg
Base-Neutral Extractables	Gas Chromatography - Mass Spectrometry	8250	1.0 mg/kg
Priority Pollutant Metals	ICAP	6010	(metal specific)
Cyanide	Distillation-Titration -Spectrophotometric	9010	5-10 mg/kg
Arsenic	AA/Gaseous Hydride	7061	0.05 mg/kg
Acid & Base/Neutral Fraction Mix	Gas chromatography -mass spectrometry	8270	1.0 mg/kg
Geotechnical Analyses			
Visual Classification of Soils		ASTM D-2488	
Natural Moisture Content		ASTM D-2216	
Unit Dry Weight			
Atterberg Limits			
Liquid		ASTM D-0423	
Plastic		ASTM D-0424	
Shrinkage		ASTM D-0427	
Grain Size			
Wet sample prep.		ASTM D-2217	
Dry sample prep.		ASTM D-0421	
Analysis		ASTM D-0422	
Unconfined compressive strength			
Vertical permeability		ASTM D-2434	

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5.3 Documentation

All analytical results will be thoroughly documented in ink and in reproduction quality. Duplicate records will be kept whenever possible. Project records will be maintained in a secure area.

For each analytical result, including all blanks, spikes, calibration standards, surrogates and samples, supporting documentation will be maintained that includes at least the following:

- Complete chain-of-custody records for the sample
- Records of traceability to EPA Reference Materials, NBS Reference Materials, or appropriate, recognized standards for all analytical standards, surrogate standards, spikes, balance calibration weights, and volumetric standads.
- Records of all sample preparation, including weights and volumes of reagents, dilution ratios, etc. These records should be in laboratory notebooks, and/or formalized data sheets, and should undergo regular review by a supervisor or quality control office. All notebook pages and data sheets should be signed and dated by originator and reviewer.
- Documentation of all manual calculations in reproduction quality.

5.4 Data Validation

All data will be validated by the laboratory prior to issuance. Validation will consist of both a statistical review and a documentation review. Statistical review will include examination of all quality control data, including field blanks, reagent blanks, method blanks, surrogates and standard calibration, as applicable. Documentation review for both chemical and geotechnical analyses will include inspection of supporting documentation for completeness, correctness and legibility, as described in Section 3.0

6.0 NUMERICAL ANALYSIS AND PEER REVIEW

All numerical analyses, including manual calculations, mapping, and computer modeling will be documented and subjected to quality control review in accordance with SOP 2005, Numerical Analysis and Peer Review. All records of numerical analyses will be legible, reproduction-quality and complete enough to permit logical reconstruction by a qualified individual other than the originator.

7.0 AUDITS AND CORRECTIVE ACTION

Periodic audits will be conducted to assess the level of adherence to this QA plan. Routine audits of field logs and other controlled field documents will be conducted by the Project Quality Assurance Officer.

When quality deficiencies are observed that warrant immediate attention, corrective action requests will be issued to the project manager by the Quality Assurance Officer.

The Project Quality Assurance Officer maintains a record of all corrective action requests and reports their status to Koppers management.

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APPENDIX A

STANDARD OPERATING PROCEDURES

1. Purpose and Applicability

This document describes procedure for ensuring that all data analyses for site investigations are consistent with project objectives and are legibly and permanently documented.

2. Responsibilities

The responsibility for implementation of this procedure on each project rests with the project manager.

3. Method of Documentation

3.1 Manual Calculations

3.1.1 All calculations shall be documented in legible, reproduction-quality records. The records shall be complete enough to permit logical reconstruction by a qualified person other than the originator.

3.1.2 Calculations should be maintained in division files during the project, and shall be placed into the central project file at the end of the project.

3.1.3 Each calculation should be assigned a unique identification number by an appropriate person.

3.1.4 Calculations for each project should be kept in a binder with an index sheet.

3.1.5 Records of calculations shall be contain, on each page, the initials of the originator and reviewer, the date, the project number, calculation number and page number.

3.1.6 The complete record of any series of calculations for a project shall have a cover page containing at least the following:

- o Statement of purpose
- o Total number of pages
- o Brief description of method
- o Assumptions and justifications
- o Reference to input data sources
- o All numerical calculations, showing all units

- o Results
- o Reference to associated computer output
- o Signature of originator and date

3.2 Computer Programs

Documentation and qualification procedures for :-written computer programs are detailed in SOP ____. Each revision of each program is documented in an annotated hard copy of the software. Annotations should be sufficient to permit a qualified individual other than the originator to understand how the program works. Minimum contents of such a record are:

- o Program name
- o Originator's name
- o List of called subroutines
- o Date of printout
- o Revision number
- o Each page should be numbered, and should indicate the total number of pages in the record

These records are archived along with the qualification records in a central file.

3.3 Computer Program Output

3.3.1 All final computer program output used in a given project will be retained in hard copy in the project files. The output should be bound and assigned a unique reference number.

3.3.2 Each program output record shall contain at least the following:

- o Name and revision date of program or model used
- o Input parameters
- o Name of user
- o Date of run

3.4 Drawings

3.4.1 All drawings shall be labeled with a unique identification number

3.4.2 All drawings shall be constructed using standardized symbols and nationally-recognized drafting standards

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3.4.3 All drawings shall be signed and dated by the originator and by a Quality Control Reviewer

3.4.4 All drawings to be published must be approved for issue by the project manager or his designee.

4. Method for Review and Revision

4.1 All manual calculations for each project shall be verified by a qualified person other than the originator.

4.2 Verification shall consist of a thorough check of the manual calculations for the following elements:

- o Appropriateness of method,
- o Appropriateness of assumptions,
- o Correctness of calculations,
- o Completeness of references,
- o Completeness of record.

4.3 <u>Method of Review</u> - It is the responsibility of the reviewer to assure that the methodology used and results obtained are correct. This may require verification of each number in the calculation, but this is usually not necessary. Typically, spot checks of the computations and visual inspection for the reasonableness constitute a sufficiently thorough check.

In some cases, it may be appropriate and economically feasible for the reviewer to perform a complete, independent calculation using a different, but appropriate method.

It is up to the reviewer to determine the appropriate method of review.

4.4 If the reviewer recommends revisions, the reviewer and originator will confer until any disagreements are resolved.

4.5 After determining that the calculation is acceptable, the reviewer will sign and date the cover page and initial and date the remaining pages.

4.6 A photocopy of the approved calculation record is made and filed in the central project file.

STANDARD OPERATING PROCEDURE

Title: Subsurface Soil Sampling

Date: 1st Qtr 198
Number: SOP 7115
Revision: 1

1.0 General Applicability

This SOP describes the methods used in obtaining subsurface soil samples for identification of soil grain-size distributions, stratigraphic correlations, and chemical analysis (if required). Subsurface soil samples are obtained in conjunction with soil boring and monitoring-well installation programs and provide direct information as to the physical makeup of the subsurface environment. This SOP covers subsurface soil sampling by split-spoon only, as this is the means most often used for obtaining samples from unconsolidated deposits. (See also, SOP 7220 - Monitoring Well Construction).

2.0 Responsibilities

It shall be the responsibility of the contract driller to provide the necessary materials for obtaining subsurface soil samples. This includes the split-spoon sampler and sample containers (sized according to project requirements) as well as the appropriate boring logs. It is the contract driller's responsibility to maintain a complete set of boring logs for contract purposes. Standard Penetration Tests (SPT) (ASTM: 1586-67) will be conducted by the contract driller if required by the project. Equipment decontamination shall also be the responsibility of the driller.

It shall be the responsibility of the project geologist/engineer to observe all activities pertaining to subsurface soil sampling to ensure that all the standard procedures are followed properly, and to record all pertinent data on a boring log. It is also the geologist/engineer's responsibility to indicate to the contract driller at what specific depth samples shall be collected. The geologist/engineer will maintain custody of all samples until they are shipped to their appropriate destination.

3.0 Supporting Materials

In addition to those materials provided by the contract driller, the geologist/engineer will provide:

- analytical sample bottles and labels
- boring logs
- field notebook
- chain-of-custody forms

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STANDARD OPERATING PROCEDURE

Title: Subsurface Soil Sampling

Date: 1st Qtr
Number: SOP 7
Revision: 1

4.0 Methods or Protocol for Use

4.1 General Procedures

The sampling depth interval is typically one (1) sample per every five (5) vertical feet with additional samples taken, at the discretion of the project geologist/engineer, when significant textural, visual or odor changes are encountered.

The following are the standard procedures to be used in advancing casing and obtaining soil samples.

Specific requirements described in a project's task plan may call for deviations in the standard procedures but these will be taken into account on a project by project basis. Any deviations from specified procedures will be recorded on the boring log.

4.2 Standard Procedures - Advancing Casing

4.2.1 The casing shall be advanced to the required depth. All loose material within the casing shall be removed prior to sampling. The casing shall be advanced according to project requirements. Borings are typically advanced by two methods, drive-and-wash casing, and hollow-stem augering. The casing shall be of the flush joint or flush couple type and of sufficient size to allow for soil sampling, coring, and/or well installation. All casing sections shall be straight and free of any obstructions. Hollow-stem augers or solid flight augers with casing may be used according to specific project requirements as described in the project task plan. If hollow-stem augers are to be used, the bit shall be equipped with a plug device to be removed at the required sampling depth.

4.2.2 For those borings which encounter obstructions, the casing shall be advanced either past or through the obstruction by drilling, mechanically fracturing, or blasting (if required). If the obstruction is bedrock, a rock core shall be taken according to project requirements and following the standard procedures for rock coring (SOP # 7210).

4.2.3 The use of recirculated water shall not be permitted when casing is being driven, unless specified in the project task plan, directed and properly documented by the geologist/engineer.

4.2.4 If recirculated water is used all loose material within the casing shall be removed by washing to the required sampling depth using a minimum amount of water. Care shall be taken to limit recirculation of the wash water to those times when the water supply is extremely limited or unavailable.

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4.3 Standard Procedures - Soil Sampling

4.3.1 Subsurface soil samples shall be obtained using a split-tube type sampler (split spoon) having a 2-inch O.D. with a corresponding 1 3/8-inch I.D. and a 24-inch long sample capacity. It shall be equipped with a ball check valve and will require a flap valve or basket-type retainer for loose-soil sampling. Sampling frequency will be as stated in Section 4.1, or as otherwise specified in the project task plan.

4.3.2 Sampling depth shall be independently determined by the inspecting geologist, and any discrepancies shall be resolved prior to obtaining the sample.

4.3.3 Samples shall be obtained using the standard penetration test (SPT), which allows for determination of resistance within the deposits. The sampler shall be driven using a 140-pound hammer with a vertical drop of 30-inches using 1 to 2 turns of the rope on the cathead. A certificate indicating exact weight may be required for documentation purposes. The number of hammer blows required for every 6 inches of penetration shall be recorded on the boring log.

4.3.4 The sampler shall be immediately opened upon removal from the casing. If the recovery is inadequate, another attempt shall be made before drilling progresses. Adequate recovery should be no less than 12 inches, not including any residual wash material brought up with the sample.

4.3.5 The sample shall be split if necessary, placed in the appropriate container, labelled, and placed in the storage box. The boring log and the sample container/label should contain the following information for each sample: site name, boring location, depth, blow counts, recovery, sample number and collection date. The type of material shall be indicated in the boring logs and will be described using the Unified Soil Classification System (ASTM: D2487-69 and D2488-69).

4.3.6 The sampler shall be cleaned with water between attempts in order to prevent cross-contamination. If further decontamination is required, SOP 7600 shall be consulted.

4.3.7 Proper procedures for delivery to the designated laboratory shall be initiated when all samples are collected. This includes packaging, shipping with sample logs, analysis request forms, and chain of custody forms.

5.0 Documentation

Various forms are required to ensure that adequate documentation of each sample is followed and will include:

- sample logs
- boring logs
- chain of custody forms
- shipping forms

In addition, a field log book will be kept as an overall log of all samples collected throughout the study. All documents are retained in the appropriate project files idefinitely.

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Project ____ Site ____ **BORING** ____ Sh 1 of ____
Date Started ____ Completed ____ Ground Elevation ____
Total Depth ____ Location ____ Logged by ____
Casing I.D. ____ Contractor ____
Remarks ____

Elev. Feet	Depth Feet	Sample				Graphic Log	Sample Description	Equipment Installed
		Type & Number	Blows per 6 In.	Depth Range	Rec.			
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STANDARD OPERATING PROCEDURE

Title: Surface-Water Sampling Techniques

Date: 1st Qtr. 19
Number: 7120
Revision: 1

4.0 Procedures

4.1 Sample Location Selection

The selection of the precise sampling location requires professional judgment and an understanding of the purpose of the study. Sampling locations where mixing is incomplete should be avoided if an average composition is required. Often, areas of poor lateral or vertical mixing can be visually identified. For example, color or turbidity differences may be apparent immediately below the confluence of a tributary and the main river or at a wastewater discharge point. Use of a field conductivity meter is recommended for determining the uniformity of the water composition across the width and depth of the water body. Once the sampling point has been selected, it must be fixed by detailed description, maps, or with the aid of stakes, buoys, or other landmarks so that others can identify the sampling location.

4.2 Stream Sampling

4.2.1 In shallow streams (those which can be safely traversed on foot) the sample container can be filled directly with the flowing water. Unless otherwise specified in the project sampling program, samples should be collected at mid-depth in the mid-section or deepest flow channel of the stream.

4.2.2 In deep rivers, use of a boat or raft will usually be required to obtain a representative sample. As with shallow streams, samples should be obtained at mid-depth in the mid-channel unless otherwise specified in the sampling program. Stream depth can be determined using a depth sounder or by physical measurement with a heavily weighted flexible measuring tape or a rigid gage.

4.2.3 An Alpha horizontal type sampler should be used for collecting samples at a specific depth in the water column. Figure 1 illustrates the operation of one of these samplers.

4.3 Lake and Pond Sampling

4.3.1 Water in lakes and ponds is generally poorly mixed and thermal stratification is frequently observed. Single samples can only represent the specific spot from which they were obtained. For many studies, samples taken at the inlet(s) and/or outlet of the lake or pond are of the most interest. In other studies, a grid is established over the lake or pond and samples are collected at grid-line intersections.

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STANDARD OPERATING PROCEDURE

Title: Surface-Water Sampling Techniques

Date: 1st Qtr.
Number: 7120
Revision: 1

1.0 Applicability

This Standard Operating Procedure (SOP) defines the basic techniques and general considerations to be followed for the collection of water-quality samples from rivers, lakes and ponds. The specific details of actual sample collection are highly dependent upon local conditions as well as upon the purpose of the water-quality study. Nevertheless, certain aspects of sample collection procedures are independent of project-specific variations.

2.0 Responsibilities

The project manager is responsible for ensuring that a properly designed sampling program is prepared prior to any sample collection. The sampling program will identify the general sampling location(s), frequency, sample type (grab or composite), water-quality parameters and analytical procedures. The field team is responsible for familiarizing themselves with the sampling program, and ensuring that all field equipment is in proper operating condition and that the appropriate sample containers and preservatives are available. The field team is also responsible for proper sample handling as specified in SOP 7510, Handling and Storage of Samples.

3.0 Materials

- Project specific sampling program
- Site area maps (e.g., USGS 7-1/2 minute or 15 minute quadrangle topographic maps)
- Sample containers and preservatives
- Insulated containers (e.g., coolers) for sample storage and an ample supply of ice
- Field equipment as specified in the sampling program and the corresponding manufacturer's manuals.
- Calibration standards for field equipment
- Alpha horizontal type sample collector (for deep rivers, lakes and ponds)
- Boat or raft (for deep rivers, lakes and ponds)
- Weighted tape measure or rigid gage
- Field-data sheets and/or log book
- First aid kit

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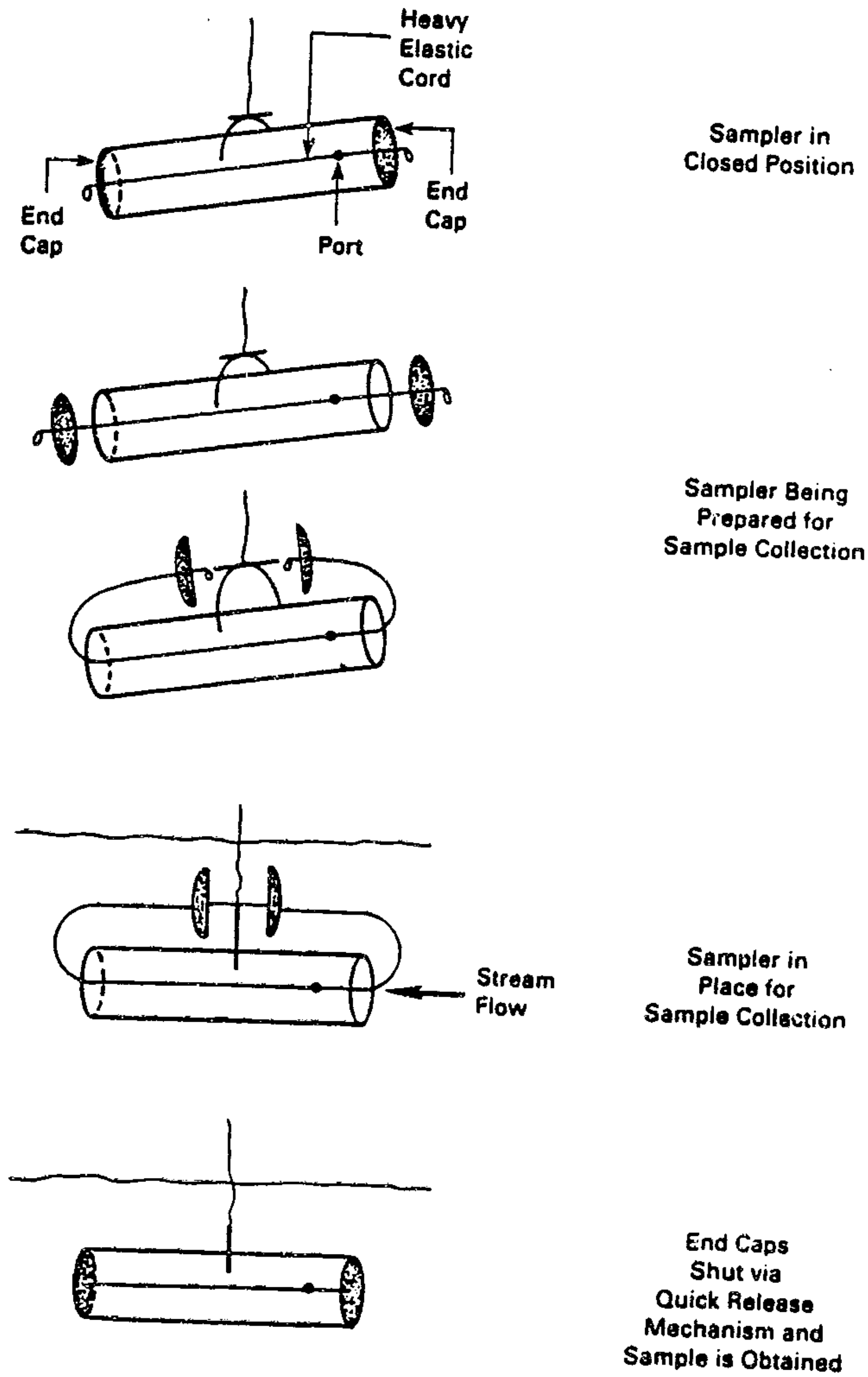

Figure 1 Alpha Horizontal Type Sampler

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4.3.2 As with deep rivers, an Alpha horizontal type sampler should be used for sample collection.

4.4 Sample Handling and Preservation

4.4.1 In general, the shorter the time lapse between sample collection and analysis, the more reliable the results will be. Certain water-quality parameters, especially pH, temperature and dissolved oxygen, are so closely related to the environment of the water that meaningful results can only be obtained by in-situ field measurements.

4.4.2 EPA has developed a list of recommended sample containers, preservatives and maximum holding times for water quality measurements (see Federal Register 44:69464). Unless otherwise specified in the sampling program, this list should be followed. Preservatives may be added to the sample containers in the field after filling, or the containers can be pre-spiked with the preservative. All samples should be placed on ice immediately after collection and should remain iced until delivery to the analytical laboratory.

5.0 Documentation

A record must be kept of every sample collected and every bottle must be clearly marked, preferably with a waterproof label. An example field-data sheet is provided in Figure 2. Project-specific data sheets or log books may be used. The field record must provide positive sample identification as well as the name of the sample collector, the date, time and exact location of the sample collection point, and results of all field water quality measurements. Other information such as weather and stream-flow conditions should also be noted. All documentation will be retained in the appropriate project files.

WATER QUALITY FIELD DATA SHEET

Title	Date	Time	Project No.	Proposal No.

Location ____________________

Station No. ____________________ Station Name ____________________

Observers ____________________

Comments ____________________

____

____

Location Within Transect* ____________________

Total Depth ____________________ Secchi Disc Depth ____________________

FIELD MEASUREMENTS

Depth (meters)	Temp (°C)	DO (mg/1)	DO Sat. (%)	Conductivity (umhos/cm)	pH (units)	Depth (meters)	Velocity (ft/sec)

*Left bank and right bank are determined facing downstream.

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Figure 2 Example Field Data Sheet

STANDARD OPERATING PROCEDURE

Title: Ground-Water Sample Collection from Monitoring Wells

Date: 1st Qtr 1984
Number: 7130
Revision: 0

1.0 Applicability

This Standard Operating Procedure (SOP) is concerned with the collection of valid and representative samples from ground-water monitoring wells. The scope of this document is limited to field operations and protocols applicable during ground-water sample collection.

2.0 Responsibilities

The site coordinator or his delegate will have the responsibility to oversee and ensure that all ground-water sampling is performed in accordance with the project-specific sampling program and this SOP. In addition, the site coordinator must ensure that all field workers are fully apprised of this SOP. The field team is responsible for proper sample handling as specified in SOP 7510, Handling and Storage of Samples.

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3.0 Supporting Materials

The list below identifies the types of equipment which may be used for a range of ground water-sampling applications. From this list, a project-specific equipment list will be selected based upon project objectives, the depth to ground-water, purge volumes, analytical parameters and well construction. The types of sampling equipment are as follows:

- Purging/Sample Collection

  Bailers
  Centrifugal Pump
  Submersible Pump
  Peristaltic Pump

- Sample Preparation/Field Measurement

  pH Meter
  Specific Conductance Meter
  Filtration Apparatus
  Water-Level Measurement Equipment

Additional equipment to support sample collection and provide baseline worker safety will be required to some extent for each sampling task. The additional materials are separated into two primary groups: general equipment which is reusable for several samplings, and materials which are expendable.

- General

  Project-specific sampling program
  Goggles or equivalent eye protection
  Full- or half-mask respirators
  Deionized-water dispenser bottle
  Methanol-dispenser bottle

  Field data sheets and/or log book
  Preservation solutions
  Sample containers
  Buckets and intermediate containers
  Coolers
  First-Aid kit

- Expendable Materials

  Bailer Cord
  Respirator Cartridges
  Gloves
  Water Filters
  Chemical-free paper towels
  Plastic sheets

4.0 Water-Level Measurement

4.1 Introduction

Prior to obtaining a water-level measurement, cut a slit in one side of the plastic sheet and slip it over and around the well, creating a clean surface onto which the sampling equipment can be positioned. This clean working area should be a minimum of eight feet square. Care will be taken not to kick, transfer, drop, or in any way let soil or other materials fall onto this sheet unless it comes from inside the well. Do not place meters, tools, equipment, etc. on the sheet unless they have been cleaned first with a clean rag.

After unlocking and/or opening a monitoring well, the first task will be to obtain a water-level measurement. Water-level measurements will be made using an electronic or mechanical device. Electronic measurement devices will be used in all wells wherein a clearly audible sound cannot be produced with a mechanical device.

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4.2 Well Security

Unlock and/or open the monitoring well. Enter a description of condition of the security system and protective casing on the Ground-Water Sample Collection Record shown in Table 1.

4.3 Measuring Point

Establish the measuring point for the well. The measuring point location should be clearly marked on the outermost casing or identified in previous sample collection records. If no measuring point can be determined, a measuring point should be established. The measuring point should be a point which is, or can easily be transposed vertically to, the survey control point for the well. Typically the top of the protective or outermost well casing will be used as the measuring point. The measuring point location should be described on the Ground-Water Sample Collection Record.

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4.4. Measurement

To obtain a water-level measurement lower a decontaminated mechanical or an electronic sounding unit into the monitoring well. Care must be taken to assure that the water-level measurement device hangs freely in the monitoring well and is not adhering to the wall of the well casing. The water-level measuring tape will be lowered into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined by repeatedly raising and lowering the tape to converge on the exact measurement. The water-level measurement should be entered on the Ground-Water Sample Collection Record.

4.5 Decontamination

The measurement device shall be decontaminated immediately after use. Two persons are usually required to perform decontamination. Two handfuls of chemical-free paper towels will be obtained and one of which will be soaked with methanol. As the tape or line is rolled back onto the reel by one person, the second will wipe all free liquids and moisture from the tape or line with one towel closest to the reel, and follow with a second wipe of methanol a few inches behind.

5.0 Purge-Volume Computation

All monitoring wells to be purged prior to sample collection. Depending upon the ease of purging, 4 to 10 volumes of ground water present in a well shall be withdrawn prior to sample collection. The volume of water present in each well shall be computed using the two measurable values, length of water column and monitoring well inside diameter. The water column length shall be computed as shown in Item 2b of Table 1. The monitoring-well diameter may be obtained by direct measurement in the field or from the boring log. Figures 1(a) and 1(b) will be used to compute the well volume. The one (1) well volume shall be multiplied by the appropriate factor (i.e. 4-10) to obtain the total purge volume.

6.0 Applications of Well-Purging and Sample-Collection Methods

6.1 Introduction

Purging must be performed for all ground-water monitoring wells prior to sample collection. The following sections explain the procedures to be used to purge and collect samples from monitoring wells.

Three general methods are used for well purging. Well purging may be achieved using bailers, surface pumps, or down-well submersible pumps.

In all cases pH and/or specific conductance will be monitored during purging. Field parameter values will be entered on the Ground-Water Sample Collection Record along with the corresponding purge volume.

6.2 Bailing

In many cases bailing may be the most convenient method for well purging. The cost of bailers and their relative size allows that many be transported easily to be available for a field sampling program so that it is not necessary to decontaminate or clean bailers between sample points. The small size of bailers allows that complete cleaning be performed without extensive decontamination facilities. ERT typically uses thin wall Teflon® bailers which are translucent, and can be readily disassembled for cleaning. These bailers contain approximately one liter (3.78 liters = 1 gallon) when full.

Bailing presents two potential problems with well purging. First, increased suspended solids may be present in samples as a result of the turbulence caused by raising and lowering the bailer through the water column. High solids concentrations may require that total suspended solids (TDS) and the chemical character of solids be evaluated during sample analyses. Second, bailing may not be feasible for wells which require that greater than twenty (20) gallons be removed during purging. Such bailing conditions mandate that long periods be spent during purging and sample collection. All ground-water collected from monitoring wells for subsequent volatile organic analyses shall be collected using bailers, regardless of the purge method.

6.3 Surface Pumping

Ground-water withdrawal using pumps located at the ground surface is commonly performed with centrifugal or peristaltic pumps.

All applications of surface pumping will be governed by the depth to the ground-water surface. Peristaltic and centrifugal pumps are limited to conditions where ground water need only be raised through approximately 20-25 feet of vertical distance. The lift potential of a surface pumping system will depend upon the net positive suction head of the pump and the friction losses associated with the particular suction line.

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Surface pumping can be used for many applications of well purging and ground-water sample collection. In all cases, pumping cannot be used for the collection of samples to be analyzed for volatile organic compounds.

6.3.1 Peristaltic Pump

Peristaltic pumps provide a low rate of flow typically in the range of 0.02-0.2 gallons/min (75-750 ml/min). For this reason, peristaltic pumps are not particularly effective for well purging. Peristaltic pumps are suitable for purging situations where a relatively long time is available for purging. Peristaltic pumps will lift water a maximum of approximately 20 - 25 feet. Peristaltic pumps are most often used for the field filtering of samples and therefore they are most often used to obtain water samples, from purged monitoring wells for direct filtration.

6.3.2 Centrifugal Pump

Centrifugal pumps are designed to provide a high rate of pumping, in the range of 10-40 gallons per minute (gpm). Centrifugal pumps can be used to pump at lower rates (1-5 gpm) if friction losses in the suction line are large, the pump drive motor is maintained at low speeds, or a valve is used to regulate discharge.

When centrifugal pumps are used, samples will be obtained from the suction line during pumping by an entrapment scheme as shown in Figure 2. While pumping is ongoing the containment valves will be closed and immediately thereafter the pump will be shut-off. The breather plug will then be opened and the sample obtained from the stopcock. This method will not be used for the collection of samples for analyses of volatile organic compounds.

Two methods, direct connection or down well suction line may be used for well purging and/or sample collection by centrifugal pumps.

Table 2 provides a summary of the advantages, disadvantages and applications for each of the two methods.

6.3.2.1 Direct Connection

The Direct Connection method is used to collect ground-water samples with centrifugal pumps. As with all pumping methods sample turbulence precludes the use of pumping for the collection of samples for analyses of volatile organic compounds.

Direct Connection requires that a suction line system be constructed which will allow that sample collection be performed on the suction side of the pump so that sample contamination due to pump contact is eliminated. In addition, the valve system on the suction line will provide a mechanism for the control of pumping. Each time pumping stops a value will be closed immediately to prevent the return of water to the well which has contacted the pump.

6.3.2.2 Down-Well Suction Line

Down-well suction lines are used where direct connection cannot be made to the well riser pipe. Down-well suction lines are used for applications when purging should include raising and lowering the suction tubing throughout the entire length of the water column.

The down-well suction line method basically requires that a continuous length of tubing be used from the pump to the end of suction line. For this reason, the method is only used for well purging because samples can only be collected from the discharge side of the pump.

6.3.3 Submersible Pump

Submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than twenty (20-30) feet and the depth or diameter of the well requires that a large purge volume be removed during purging. Submersible pumps also provide a continuous discharge which allows that less variability be encountered with samples collected by this method.

ERT uses the Johnson-Keck pump model SP-81 which has a 1.75 inch diameter pump unit. The pump diameter restricts use to monitoring wells which have inside diameters equal to or greater than two (2) inches. As with other pump-type purge/sample collection methods, submersible pumps will not be used for the collection of samples for analyses of volatile organic compounds.

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7.0 Purging- and Sample-Collection Procedures

7.1 Bailing

7.1.1 Obtain a clean/decontaminated bailer and a spool of polypropylene rope or equivalent bailer cord. Using the rope at the end of the spool tie a bowline knot or equivalent through the bailer loop. Test the knot for adequacy by creating tension between the line and the bailer. Tie again if needed.

7.1.2 Remove the aluminum foil wrapping from the bailer, and, while holding the bailer, place it inside the well to verify that an adequate annulus is present between the bailer and the well casing to allow free movement of the bailer.

7.1.3 Lower the bailer to the bottom of the monitoring well and remove an additional five feet of cord from the spool. Cut the cord at the spool and secure the rope to the well head or the wrist of the person who shall perform the bailing.

7.1.4 Raise the bailer by grasping a section of cord using each hand alternately. This bailer lift method will provide that all of the bailer cord will not come into contact with the ground or other potentially contaminated surfaces.

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7.1.5 Bailed ground water will be poured from bailer into a graduated bucket to measure the purged water volume.

7.1.6 During sample collection bailers will be lowered to the bottom of monitoring wells and withdrawn slowly through the entire water column.

7.1.7 Samples collected by bailing will be poured directly into sample containers from bailers which are full of fresh ground water. During sample collection, bailers will not be allowed to contact the sample containers.

7.2 Peristaltic Pump

7.2.1 Place a new suction and discharge line in the peristaltic pump. Silicon tubing must be used through the pump head. A second type of tubing may be attached to the silicon tubing to create the suction and discharge lines. Such connection is advantageous for the purpose of reducing tubing costs, but only be done if airtight connections can be made. Tygon tubing will not be used when performing well purging or collecting samples for organic analysis. The suction line must be long enough to extend to the static ground-water surface and reach further should drawdown occur during pumping.

7.2.2 Measure the length of the suction line and lower it down the monitoring well until the end is in the upper 2-5 inches of the water column present in the well. Start the pump and direct the discharge into a graduated bucket.

7.2.3 Measure the pumping rate in gallons per minute by recording the time required to fill a selected volume of a bucket. Flow measurement shall be performed three times to obtain an average rate.

7.2.4 The pumping shall be monitored to assure continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts. The suction line will be lowered to assure that the end of the suction line is maintained in the uppermost 2-5 inches of the water column.

7.2.5 Measurments of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record.

7.2.6 Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and Specific Conductance) have stabilized.

7.2.7 When the sample bottles are prepared, each shall be filled directly from the discharge line of the peristaltic pump. Care will be taken to keep the pump discharge line from contacting the sample bottles. Ground-water samples requiring filtration prior to placement in sample containers, will be placed in intermediate containers for subsequent filtration or filtered directly using the peristaltic pump.

7.2.8 At each monitoring point when use of the peristaltic pump is complete, all tubing including the suction line, pump head and discharge line must be disposed of. In some cases where sampling will be performed frequently at the same point, the peristaltic pump tubing may be retained between each use in a clean zip-lock plastic bag.

7.3 Centrifugal Pump

7.3.1 Direct Connection Method

7.3.1.1 Establish direct connection to the monitoring well using pipe connections, extensions, and elbows, with Teflon® tape wrapping on all threaded connections. If the centrifugal pump will subsequently be used for sample collection, a sample isolation chamber will be placed in the suction line configuration as shown in Figure 2.

7.3.1.2 Prime the pump by adding tap water to the pump housing until the housing begins to overflow.

7.3.1.3 Start the pump and direct the discharge into a graduated bucket or a bucket of known capacity (>2.5 gallons).

7.3.1.4 Measure the pumping rate in gallons per minute by recording the time required to fill a selected volume of a bucket. Flow measurement should be performed three times to obtain an average rate. Pumping will be observed at all times to determine if pumping rates are continuous, fluctuating, or diminishing. If discharge stops, the pump will be throttled back to determine if pumping will restart at a lower rate. If pumping does not

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restart, the pump should be shut off to allow the well to recharge.

7.3.1.5 Measurements of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record.

7.3.1.6 Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and Specific Conductance) have stabilized.

7.3.1.7 While pumping is on-going the containment valves in the Sample Isolation Chamber will be closed and the pump immediately shut off.

7.3.1.8 When the sample bottle is prepared, the breather plug will be removed and the stopcock at the sample collection point opened and the sample bottle filled.

7.3.1.9 At each monitoring well when use of a centrifugal pump is complete, all suction line parts will be decontaminated in accordance with the SOP for Decontamination.

7.3.2 Down-Well Suction-Line Method

7.3.2.1 Lower a new suction line into the well. The suction line will have a total length at least great enough to extend to the water table and account for a minimum of five (5) feet of drawdown. Note should be made that drawdown may exceed the depth where pumping will terminate as a result of a limitation derived from suction-line conditions and the lift potential of the pump. All connections will be made using Teflon® ferrules and Teflon® thread wrapping tape.

7.3.2.2 Prime the pump by adding tap water to the pump housing until the housing begins to overflow.

7.3.2.3 Start the pump and direct the discharge into a graduated bucket or a bucket of known capacity (>2.5 gallons).

7.3.2.4 Measure the pumping rate in gallons per minute by recording the time required to fill a selected

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volume of a bucket. Flow measurement should be performed three times to obtain an average rate. Pumping will be observed at all times to determine if pumping rates are continuous, fluctuating or diminishing. If discharge stops, the pump will be throttled back to determine if pumping will restart at a lower rate. If pumping does not restart, the pump should be shut off to allow the well to recharge.

The rate of recharge will be measured by inserting water-level measurement equipment down the well to determine approximately at what rate the well is recharging, and therefore when pumping may be restarted. All information pertaining to discharge conditions and recharge rates will be entered on the Ground-Water Sample Collection Record.

7.3.2.5 Measurements of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record.

7.3.2.6 The valve at the pump on the line will be closed whenever pumping terminates or pumping is stopped. This practice will minimize the return to the well of water which has contacted the inside of the pump housing.

7.3.2.8 At each monitoring well when use of a centrifugal pump is complete all suction line tubing will be disposed of.

7.4 Submersible Pump

7.4.1 Prior to using a submersible pump, a check will be made of well diameter and alignment. A 1.75 inch diameter decontaminated cylindrical tube will be lowered to the bottom of each monitoring well to determine if the alignment or plumbness of a well is adequate to accommodate the submersible pump. The well alignment survey may also be used to determine the total depths of wells. All observations will be entered in the Ground-Water Sample Collection Record.

7.4.2 Slowly lower the submersible pump into the monitoring well taking notice of any roughness or restrictions within the riser.

7.4.3 Count the graduations on the pump discharge line and stop lowering when the stainless steel portion is below the uppermost section of the static water column within monitoring well. Secure the discharge line and power cord to the well casing.

7.4.4 Connect the power cord to the power source (i.e., rechargeable battery pack or auto battery monitor) and turn the pump on (forward mode). When running, the pump can usually be heard by listening near the well head.

7.4.5 Voltage and amperage meter readings on the pump discharge will be checked continuously. The voltage reading will decline slowly during the course of a field day representing the use of power from the battery. Amperage readings will vary depending upon the depth to water table. Amperage readings greater than 10 amps usually indicate a high solids content in the ground water in which cases pump clogging will most likely occur. If a steady increase in amperage is observed, the pump should be shut off, allowed to stop, switched to the reverse mode, stopped again and then placed in forward mode. If high amperage readings persist, the pump should be withdrawn and checked using the large upright cylinder and tap water. Ground-water conditions such as high solids may require that an alternate purge/sample method be used.

7.4.6 Drawdown will be monitored continuously by remaining near the well at all times and listening to the pump. When drawdown occurs, a metallic rotary sound will be heard as the pump intake becomes exposed and ceases to discharge water, but continues to run. The pump will be lowered immediately to continue pumping water within the uppermost section of the static water column. NOTE: The submersible pump will not be allowed to run while not pumping for more than five seconds.

If drawdown continues to the extent that the well is pumped dry, the well will be allowed to recharge. The rate of recharge will be approximately determined by re-starting the submersible pump after a ten (10) minute period with the pump off. The pumping rate shall be re-measured and/or the total discharge volume collected to determine the recharge volume.

7.4.7 Direct the pump discharge to a graduated bucket or a bucket of known capacity.

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7.4.8 Measure the pumping rate in gallons per minute by recording the time required to fill a selected volume of a bucket. Flow measurement shall be performed three times to obtain an average rate. The performance of a submersible pump will be observed at all times by at least one field worker.

7.4.9 Measurements of pH and specific conductance will be made periodically during well purging. All readings and respective purge volumes will be entered on the Ground-Water Sample Collection Record.

7.4.10 Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and specific conductance) have stabilized.

7.4.11 While pumping is on-going and when sample bottles are prepared, bottles will be filled directly from the discharge line of the pump taking care not to touch sample bottles to the discharge line.

7.4.12 At each monitoring well when use of the submersible pump is complete, the pump, discharge line and power cord shall be decontaminated according to the procedures contained in the SOP for Decontamination.

8.0 Sample Preparation

8.1 Introduction

Prior to transport or shipment, ground-water samples may require preparation and/or preservation. Field preparation may entail filtration, or preservation in the form of chemical additives or temperature control.

Specific preservation techniques are described in the EPA document, Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA-600/4-82-029). The EPA manual will be consulted during the planning stage of the project. Project-specific sampling plans shall be assembled using the approved procedures obtained from the EPA manual.

8.2 Filtration

Ground-water samples collected for dissolved metals analyses will be filtered prior to being placed in sample containers. Ground-water filtration will be performed using a peristaltic pump and a 0.45 micron, water filter. Typically the water filters are 142 mm in diameter and are usually placed in 142 mm polycarbonate housings.

The filtration of ground-water samples shall be performed either directly from the monitoring well or from intermediate sample containers such as decontaminated buckets. In either case, well purging shall be performed first. Fresh ground water shall then be filtered and discharged from the filtration apparatus directly into sample containers. For most dissolved metal analyses, pH adjustment of the sample is required and shall be performed after filling the sample bottles.

9.0 Documentation

A number of different documents will be completed and maintained as a part of ground-water sampling. The documents will provide a summary of the sample-collection procedures and conditions, shipment method, the analyses requested and the custody history. The list of documents is:

- Ground-water sample collection record
- Sample labels
- Chain of custody
- Shipping receipts

Sample labels shall be completed at the time each sample is collected and will include the information listed below. A sample label is shown in Figure 3.

- Client or project name
- Sample number
- Designation (i.e., identification of sample point no.)
- Analysis
- Preservative (e.g., filtration, acidified pH<2 HNO_3)
- Sample-collection date
- Sampler's name

Figure 4 displays the chain of custody record used by   The chain of custody form is the record sample collection and transfer of custody. Information such as the sample collection date, sample identification and origination, client or project name shall be entered on each chain of custody record. In accordance with 40 CFR 261.4(d) the following information must accompany all ground water samples which are known to be non-hazardous and to which U.S. Department of Transportation and U.S. Post Office regulations do not apply. Such information is:

- sample collector's name, mailing address and telephone number,
- analytical laboratory's name, mailing address and telephone number,
- quantity of each sample,
- date of shipment, and
- description of sample.

The chain of custody forms provide a location for entry of the above-listed information.

10.0 References

EPA, Handbook for Sampling and Sample Preservation of Water and Wastewater EPA-600/4-82-029, September 1982.

Geotrans, Inc. RCRA Permit Writer's Manual, Ground-Water Protection prepared for U.S. EPA. Contract No. 68-01-6464, October 1983.

Code of Federal Regulations, Chapter 40 (Section 261.4(d).

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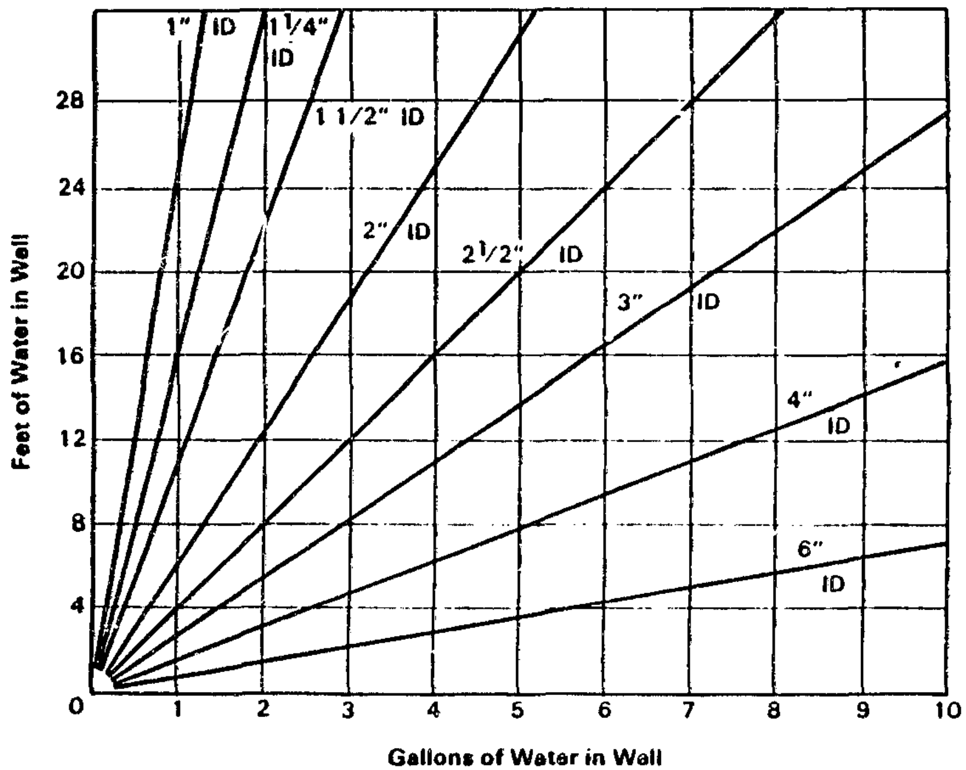

(a) Graphical Explanation

Volume/Linear Ft. of Pipe		
ID(in)	Gal	Liter
1/4	0.003	0.010
3/8	0.006	0.022
1/2	0.010	0.039
3/4	0.023	0.087
1	0.041	0.154
2	0.163	0.618
3	0.367	1.39
4	0.653	2.47
6	1.47	5.56

(b) Volume Factors

Figure 1 Purge Volume Computation

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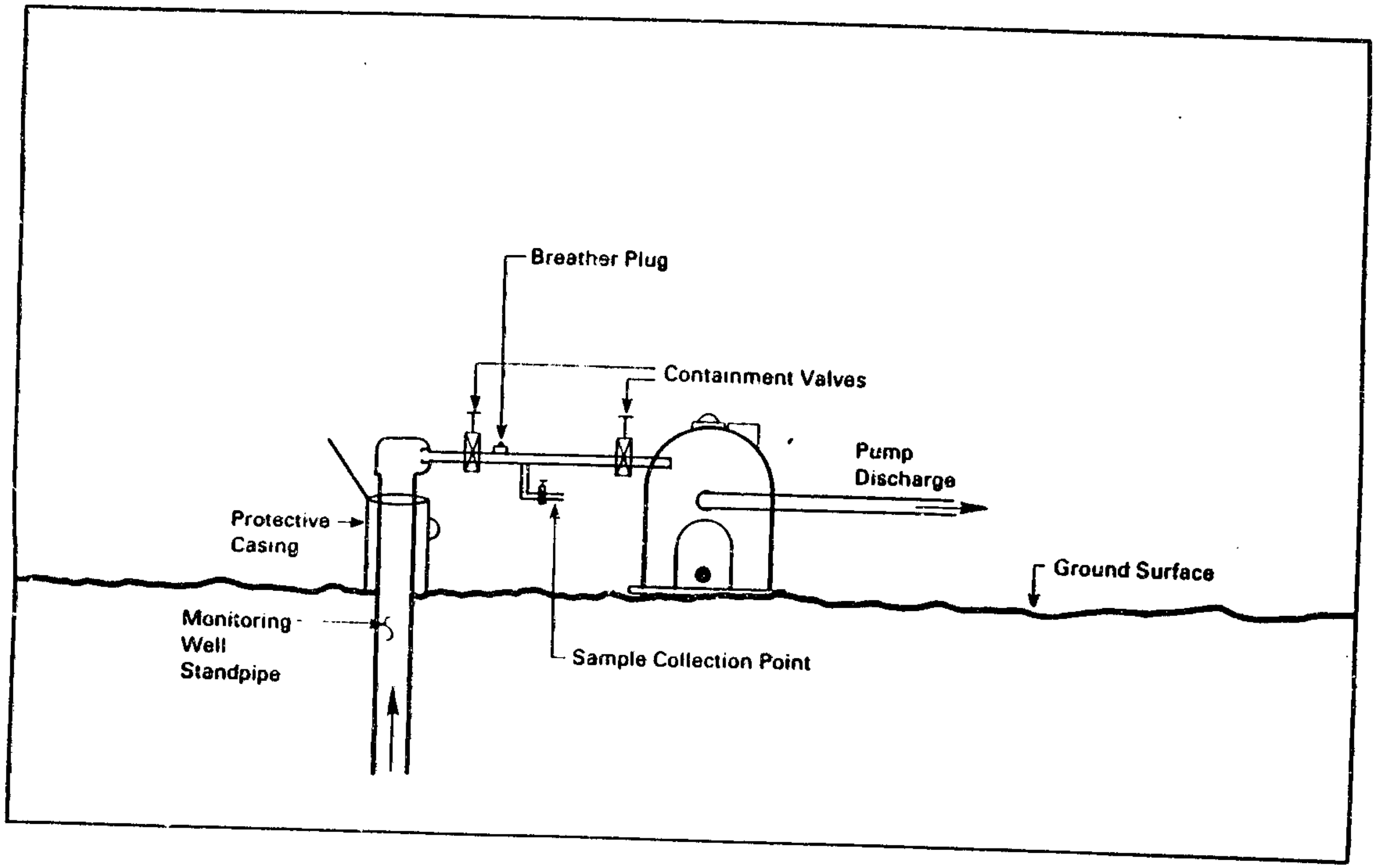

Figure 2   Down Well Suction Line Configuration

CLIENT ______________________

SAMPLE NO. ______________________

DESIGNATION ______________________

ANALYSIS ______________________

PRESERVATIVE ______________________

DATE ____ ______ BY ______________

Figure 3   Sample Container Label

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STANDARD OPERATING PROCEDURE

Title: Monitoring-Well Construction and Installation

Date: 1st Qtr 198
Number: 7220
Revision: 1

1.0 Purpose and Applicability

This SOP establishes the method for installing observation standpipes, or monitoring wells. These wells will be installed to: determine the depth to ground water, monitor ground-water fluctuations and obtain samples of ground water for laboratory testing.

2.0 Responsibilities

It is the responsibility of the project geologist/engineer to directly supervise the construction and installation of each monitoring well by the contract driller to ensure that the well-installation specifications are adhered to and to record all pertinent data on the approved forms.

3.0 Supporting Materials

The monitoring well shall consist of a commercially available well screen constructed of brass, stainless steel or slotted PVC plastic pipe of minimum 2-inch nominal ID (inside diameter). The length of the screened area and the gage of the screen or slots shall be determined by the inspecting geologist depending upon the grain-size distribution of the soils. Blank plastic, black, galvanized or stainless steel pipe of minimum 2-inch ID shall be used to complete the standpipe approximately 2 feet above the existing grade. The riser pipe shall be connected by flush, threaded joints. No solvent or anti-sieze compound shall be used on the joints.

The section of riser pipe that sticks up above ground shall be protected by 3 or 4-inch diameter steel guard pipe, up to 5 feet long set 2 feet into the concrete surface seal. The top of the guard pipe shall have a vented lockable cap.

Other materials used for well construction include silica sand, bentonite, cement, and a calibrated tape for length measurements and water-level measurements. Construction materials are generally provided by the drilling subcontractor.

4.0 Procedure for Construction

4.1 After drilling and soil sampling has been completed, the casing shall be flushed free of cuttings to develop a clean, uniform hole. Flushing shall be continued until the return water is clear.

4.2 Grouting of the borehole to the well-screen tip elevation shall be required if the tip is to be above the bottom of the borehole. A heavy plumb bob on a calibrated tape shall be used to determine the depth of the boring and the depth to the top of the grout plug.

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STANDARD OPERATING PROCEDURE

Title: Monitoring-Well Construction and Installation

Date: 1st Qtr
Number: 7220
Revision: 1

4.3 The well screen and riser pipe shall then be assembled. The assembled screen and riser or its constituent parts shall be decontaminated as described in SOP 7600, Decontamination.

4.4 The rise and screen shall be carefully placed in the borehole to ensure that it is centered in the hole.

4.5 The annular space surrounding the screened section of the monitoring well and at least two feet above the top of the screen shall be filled with clean, medium to coarse sand.

4.6 After the sand filter has been emplaced, the monitoring well shall be filled approximately 2 to 3 feet above the existing water table with clear water and the drop in water level observed to ensure that the monitoring well is functioning. If the water level does not drop at a rate consistent with the soil type at the tip, the monitoring well shall be removed and the borehole washed before the monitoring well is reinstalled.

4.7 It may be necessary to seal off the well screen by placing a grout seal on top of the sand at a specified depth. The project geologist/engineer, or shall give detailed instructions if sealing off of the well screen is required. This grouting may consist of a bentonite seal of approximately feet in thickness to prevent vertical flow within the boring from affecting the screened area.

4.8 The remaining length of borehole shall be backfilled with sand or grout to within 2 feet of the ground surface. This grouting may consist of a bentonite/cement mixture made to required specification.

4.9 The 3- or 4-inch diameter steel guard-pipe shall be placed around the riser, and the borehole around the guard pipe shall be dug out to approximately a 1-foot radius to a depth of 2 feet, and filled with concrete. All completed wells will have identification numbers clearly painted on the cap and guard pipe with bright colored paint.

5.0 Documentation Procedures

5.1 During installation of each monitoring well a series of measurements shall be taken and documented. These measurements shall include:

length of screen

length of riser pipe

total length of well

depth to stabilized water level

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Title: Monitoring-Well Construction and Installation

Date: 1st Qtr 198
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Other data include type and length of casing, diameters of the respective components, thicknesses and different types of grouting materials, and elevation of the top of the guard pipe and ground surface after surveying is complete.

5.2 All data shall be recorded on site onto the ground-water monitoring well installation report and all wells shall be referenced onto the appropriate site map. A field book and/or boring log can be used as other means of recording data. All documentation shall remain in the project files indefinitely.

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GROUND WATER STANDPIPE INSTALLATION REPORT

STANDPIPE No. ______
BORING No. ______
SH. ____ OF ____

PROJECT ____________ SITE ________ DATE: START ________ FINISH ________

LOCATION ____________ GROUND ELEV. ________ TOTAL DEPTH (FT.) ________

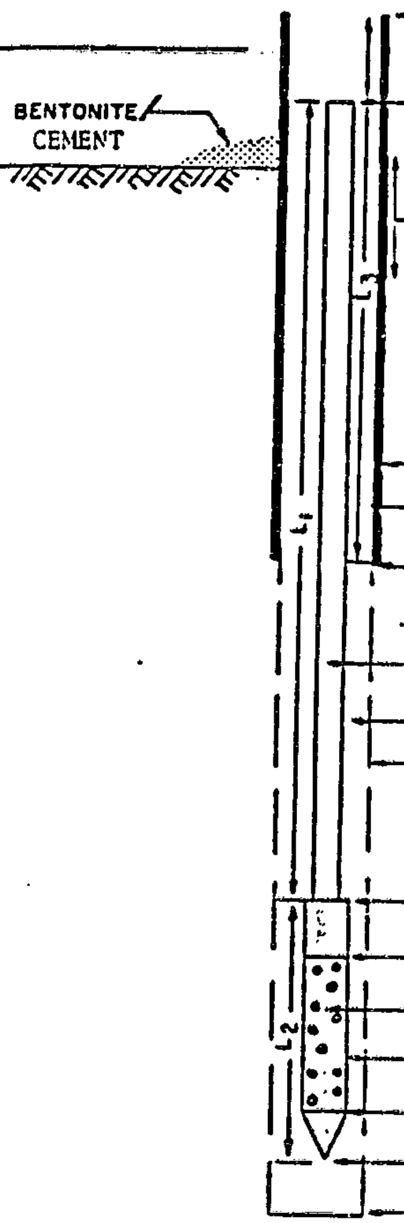
CONTRACTOR ____________ LOGGED BY ________ CHK'D BY ________

SURVEY DATUM ________

GROUND ELEVATION

BENTONITE CEMENT

LOG OF MATERIALS



ELEVATION OR STICKUP ABOVE/BELOW GROUND SURFACE OF CASING OR ROAD-WAY BOX ________

ELEVATION OR STICKUP ABOVE/BELOW GROUND SURFACE OF RISER PIPE. ________

THICKNESS OF SURFACE SEAL ________

TYPE OF SURFACE SEAL ________

[INDICATE ALL SEALS SHOWING DEPTH, THICKNESS AND TYPE]

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TYPE OF CASING ________

INSIDE DIAMETER OF CASING ________

ELEVATION/DEPTH OF BOTTOM OF CASING L3 ________

INSIDE DIAMETER OF RISER PIPE ________

TYPE OF BACKFILL AROUND RISER ________

DIAMETER OF BOREHOLE ________

ELEVATION/DEPTH OF BOTTOM OF RISER L1 ________

TYPE OF POINT OR MANUFACTURER ________

SCREEN GAUGE OR SIZE OF OPENINGS ________

DIAMETER OF WELLPOINT ________

TYPE OF BACKFILL AROUND POINT ________

ELEVATION/DEPTH OF BOTTOM OF POINT L2 ________

ELEVATION/DEPTH OF BOTTOM OF BOREHOLE ________

[________ LENGTH OF CASING L_3] [________ LENGTH OF RISER PIPE (L_1) + ________ LENGTH OF POINT (L_2)] = ________ PAY L...

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STANDARD OPERATING PROCEDURE

Title: Operation/Calibration HNu Photoionization Analyzer

Date: 1st Qtr 198(
Number: 7315
Revision: 1

1.0 General Applicability

This SOP describes the operation and calibration techniques used for the Model PI 101 Photoionization Analyzer, manufactured by HNU Systems, Inc. This instrument is designed to measure organic vapor levels. There are three direct reading ranges: 0-20 ppm, 0-200 ppm and 0-2000 ppm at a minimum gain. The detection limits is 0.1 ppm. The linear range is 0-600 ppm. The response time is less than 5 seconds to 90% of full scale. (All specifications are benzene referred).

The PI 101 is capable of operating either from a rechargeable battery for more than 10 hours or continuously from the AC battery charger. The recorder output is 0-100 MV FSD (full scale deflection).

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2.0 Responsibilities

2.1 The project geologist or engineer will be responsible for the calibration, operation and maintenance of the instrument.

2.2 The geologist or engineer and/or field coordinator will be responsible for the documentation which applies to the various procedures performed with the instrument.

3.0 Supporting Materials

- NBS - Traceable span gas cylinders:

  10 ppm Isobutylene in Z-1 air, CGA590

  150 ppm Isobutylene in Z-1 air

- Tedlar bags
- Tubing used for gas transfer from cylinder to bag (if necessary)
- AC battery charger
- "magic marker"
- appropriate forms
- activated charcoal

4.0 Methods or Protocol for Use

4.1 Standard Procedure

STANDARD OPERATING PROCEDURE

Title: Operation/Calibration HNu Photoionization Analyzer

Date: 1st Qtr
Number: 731
Revision: 1

4.1.1 Operation and calibration of the instrument should be done in a controlled environment; i.e., in the field office, interior of vehicle, etc. This is done in order to control working temperature, and to protect from vehicle exhausts, etc.

4.1.2 The probe nozzle, electrode casing handle, and cable are stored within the instrument cover. To assemble, the handle must be screwed to the electrode casing. The probe nozzle must be screwed to the opposite end of the electrode casing. The 12-pin connector at the end of the cable must then be attached to the rest of the unit by twisting it downwards until a distinct snap and lock is felt. The unit is now ready to be used.

4.1.3 Prior to calibration or use of the instrument the unit should be allowed to warm up for up to one-half hour. In this time, check to see if the UV light source is working. <u>Do not look directly at the light source</u>. Also check to see if the intake fan is working properly. It is within the electrode casing and will give off a distinct hum when the unit is turned on.

4.1.4 Check to make sure the level of charge is high enough to ensure accurate readings. When the instrument is switched to the BATTERY CHECK position, the needle should deflect upscale to well within the green area (battery level) on the face of the meter. If not, the unit should be charged using the AC charger. A 3-hour charge will bring the unit up 90% full charge. With continuous use, (e.g., unit left on for a full day), the unit should be recharged overnight for 8-10 hours.

4.2 Calibration and Maintenance

4.2.1 Calibration should be done at the beginning and at the end of each day the instrument is used, to ensure accurate readings over the full range of scale that is to be needed. Two cylinders containing Isobutylene of two different, known concentrations are to be used as calibration gases. If only one cylinder is available, it should be of high enough concentration to be within the expected range under normal use.

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STANDARD OPERATING PROCEDURE

Title: **Operation/Calibration HNu Photoionization Analyzer**

Date: 1st Qtr 198
Number: 7315
Revision: 1

4.2.2 The instrument should be given the dynamic zero check by connecting the activated charcoal cannister to the inlet probe, using flexible tubing, while operating the instrument in the sampling mode. Wait for a stable response, and then adjust the zero potentiometer until a zero reading is obtained. This zero check should be performed before and after each calibration. The charcoal in the cannister should be replaced at least once every 5 sampling days.

4.2.3 Actual calibration is done by first filling an evacuated Tedlar bag with gas from the calibration gas cylinder containing the highest gas concentration. Use the available tubing and any other hookup materials that are provided. Be absolutely sure that the Tedlar bag has been evacuated before filling it with gas. Otherwise the calibration gas will be diluted and its concentration will not be known.

4.2.4 The appropriate analyzer scale should be chosen depending on the known concentration of the calibration gas. Attach the probe nozzle to the Tedlar bag and allow it to sample the gas until a stable, unchanging reading is reported by the analyzer. Adjust the span potentiometer so that the instrument reading agrees exactly with the concentration the calibration gas. Whenever the span setting is changed the zeroing procedure (Section 4.2.2) should be repeated.

4.2.5 The calibration procedure should be repeated for the other calibration gas provided to ensure that the instrument is calibrated properly over a wide range of scale.

4.2.6 All calibration checks must be documented on the appropriate forms (calibration form, equipment status form).

4.3 Standard Operation

4.3.1 After the instrument is fully calibrated it is ready to be used. To obtain the most accurate reading, the lowest possible scale should be selected prior to sampling. To analyze a sample, the probe nozzle should be placed in close proximity to the sample taking care not to contaminate the probe with any materials (soil, water).

4.3.2 All readings should be documented on the appropriate forms (sample log, sample container label).

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4.3.3 A "magic marker" is provided to check meter response periodically. When the probe is inserted into the marker cap or next to the marker tip a reading of about 5 ppm should be obtained. Shelter the probe and marker from any wind when performing this test.

4.3.4 Meter calibration should be checked by the methods in 4.2 at the end of the day, and any appropriate changes made and documented.

5.0 Documentation

5.1 Field/Lab equipment status form

5.2 HNU PI 101 recalibration form

5.3 All documentation shall be retained in the project files.

6.0 References

Instruction Manual for Model PI 101 Photoionization Analyzer, printed by HNU Systems, Inc., 1975.

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HNU PI 101 RECALIBRATION FORM

Project Name/No. ______________________ Recalibration Date ___/___/___

Time ______________________

By Whom ______________ (Init)

Calibration Gases: Cylinder ID Number Concentration

1. ______________________ ppm

2. ______________________ ppm

Where Recalibrated: ______________

(office, field lab)

Battery Check: (Y, N)__________ Recharge Time: ________ hrs

Zero Adjust: (Y, N)__________

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First Calibration: Designated Reading ________ ppm

(use higher standard gas)

Observed Reading ________ ppm

Span Setting: Initial __________

Final __________

Post Span Observed Reading ________ ppm

Post Calibration Zero Adjust: (Y, N)______________

Second Calibration Designated Reading ________ ppm

(use lower standard)

Observed Reading ________ ppm

Final Zero Adjust: (Y, N)__________ Second Recalibration Needed (Y, N)________

Calibrated By: ______________________ Date: ___/___/___

STANDARD OPERATING PROCEDURE

Title: Operation/Calibration HNu Photoionization Analyzer

Date: 1st Qtr 1
Number: 7315
Revision: 1

FIELD/LAB EQUIPMENT STATUS FORM

Type of Equipment ______________________________

Equipment No. ______________ Mfr. ______________

Date	Calibration/ Maintenance (C, M)	Agent Used	Adjustments Made: What Type	Adjustments Made: Initial	Adjustments Made: Final	Status (OK, Hold)	Initial
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

Additional Comments:

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1284b (12/78)

STANDARD OPERATING PROCEDURE

Title: Packaging and Shipment of Samples

Date: 1st Qtr. 1984
Number: SOP 7510
Revision:

1.0 Applicability

This Standard Operating Procedure (SOP) is concerned with the presentation of protocols associated with the packaging and shipment of samples. Two general categories of samples exist: environmental samples consisting of air, water and soil; and waste samples which include non-hazardous solid wastes and hazardous wastes as defined by 40 CFR Part 261.

2.0 Responsibilities

It is the responsibility of the project manager to assure that the proper packaging and shipping techniques are entered into each project specific sampling plan. The site operations manager shall be responsible for the enactment and completion of the packaging and shipping requirements outlined in project specific sampling plans. The site operations manager shall be responsible to research, identify and follow all applicable U.S. Department of Transportation (DOT) regulations.

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3.0 General Method

The objective of sample packaging and shipping protocol is to identify standard procedures which will minimize the potential for sample spillage or leakage and maintain field sampling program compliance with U.S. EPA and U.S. DOT regulations.

The extent and nature of sample containerization will be governed by the type of sample, and the most reasonable projection of the sample's hazardous nature and constituents. The EPA regulations (40 CFR Section 261.4(d)) specify that samples of solid waste, water, soil or air, collected for the sole purpose of testing, are exempt from regulation under the Resource Conservation and Recovery Act (RCRA) when all of the following conditions are applicable:

A. Samples are being transported to a laboratory for analysis;
B. Samples are being transported to the collector from the laboratory after analysis;
C. Samples are being stored (1) by the collector prior to shipment for analyses, (2) by the analytical laboratory prior to analyses, (3) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

Qualification for categories A and B above require that sample collectors comply with U.S. DOT and U.S. Postal Service (USPS) regulations or comply with the following items if U.S. DOT and USPS regulations are found not to apply:

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STANDARD OPERATING PROCEDURE

Title: Packaging and Shipment of Samples

Date: 1st Qtr. 1984
Number: SOP 7510
Revision:

The following information must accompany all samples and will be entered on a sample specific basis on chain of custody records:

- sample collector's name, mailing address and telephone number,
- analytical laboratory's name, mailing address and telephone number,
- quantity of sample,
- date of shipment
- description of sample

In addition, all samples must be packaged so that they do not leak, spill or vaporize.

4.0 Method

4.1 Place plastic bubble wrap matting over the base and bottom corners of each cooler or shipping container as needed to manifest each sample.

4.2 Obtain a chain of custody record as shown in Figure 1 and enter all the appropriate information as discussed in Section 3.0 of this SOP. Chain of custody records will include complete information for each sample. One or more chain of custody records shall be completed for each cooler or shipping container as needed to manifest each sample.

4.3 Wrap each sample bottle individually and place standing upright on the base of the appropriate cooler, taking care to leave room for some packing material and ice or equivalent. Rubber bands should be used to secure wrapping, completely around each sample bottle.

4.4 Place additional bubble wrap and/or styrofoam pellet packing material throughout the voids between sample containers within each cooler.

4.5 Place ice or cold packs in heavy duty zip-loc type plastic bags, close the bags, and distribute such packages over the top of the samples.

4.6 Add additional bubble wrap/styrofoam pellets to fill the balance of the cooler or container.

4.7 Obtain two pieces of chain of custody tape as shown in Figure 2 and enter the custody tape numbers in the appropriate place on the chain of custody form. Sign and date the chain of custody tape.

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STANDARD OPERATING PROCEDURE

Title: Packaging and Shipment of Samples

Date: 1st Qtr. 1984
Number: SOP 7510
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4.8 To complete the chain of custody form enter the type of analysis required for each sample, by container, under the "ANALYSES" section. Under the specific analysis enter the quantity/volume of sample collected for each corresponding analysis.

If shipping the samples where travel by air or other public transportation is to be undertaken, sign the chain of custody record thereby relinquishing custody of the samples. Reliquishing custody should only be performed when directly transmitting custody to a receiving party or when transmitting to a shipper for subsequent receipt by the analytical laboratory. Shippers should not be asked to sign chain of custody records.

4.9 Remove the back carbon copy from the chain of custody record and retain with other field notes. Place the remaining copies in a zip-lock type plastic bag and place the bag on the top of the contents within the cooler or shipping container.

4.10 Close the top or lid of the cooler or shipping container and with another person rotate/shake the container to verify that the contents are packed so that they do not move. Improve the packaging if needed and reclose.

When travelling with samples by automobile, and where periodic changes of ice are required, the cooler should only be temporarily closed so that reopening is simple. In these cases, chain of custody will be maintained by the person transporting the sample and chain of custody tape will not be used.

4.11 Place the chain of custody tape at two different locations on the cooler or container lid and overlap with transparent packaging tape.

4.12 Packaging tape should be placed entirely around the sample shipment containers. A minimum of one to two full rotations of packaging tape will be placed at at least two places on the cooler. Shake the cooler again to verify that the sample containers are well packed.

4.13 If shipment is required, transport the cooler to an overnight express package terminal. Obtain copies of all shipment records as provided by the shipper.

4.14 If the samples are to travel as luggage, check with regular baggage.

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4.15 Upon receipt of the samples, the analytical laboratory will open the cooler or shipping container and sign as "received for laboratory" each chain of custody form. The laboratory will verify that the chain of custody tape has not been broken previously and that the chain of custody tape number corresponds with the number on the chain of custody record. The analytical laboratory will then forward the back copy of the chain of custody record to the sample collector to indicate that sample transmittal is complete.

5.0 Documentation

As discussed in Section 4.0 the documentation for supporting the sample packaging and shipping will consist of chain of custody records and shipper's records. In addition a description of sample packaging procedures will be written in the field log book. All documentation will be retained in the project files following project completion.

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STANDARD OPERATING PROCEDURE

Title: Decontamination

Date: 1st Qtr 198
Number: 7600
Revision: 1

1.0 General Applicability

This SOP describes the methods to be used for the decontaminization of all field equipment which becomes potentially contaminated during a sample collection task. The equipment may include split spoons, bailers, trowels, shovels, hand augers, or any other type of equipment used during field activities.

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross-contamination between samples and also helps to maintain a clean working environment for the safety of all field personnel involved, including the environment.

Decontamination is mainly achieved by rinsing with liquids which include: soap and/or detergent solutions, tap water, deionized water, and methanol. Equipment will be allowed to air dry after being cleaned or may be wiped dry with chemical free cloths or paper towels if immediate re-use is needed.

The frequency of equipment use, dictates that most decontamination be accomplished at each sampling site between collection points. Waste products produced by the decontamination procedures such as waste liquids, solids, rags, gloves, etc. will be collected and disposed of properly based on the nature of contamination. All cleaning materials and wastes should be stored in a central location so as to maintain control over the quantity of materials used and/or produced throughout the study.

2.0 Responsibilities

It is the primary responsibility of the site operations manager to assure that the proper decontamination procedures are followed and that all waste materials produced by decontamination are properly stored and disposed of.

It is the responsibility of the project safety officer to draft and enforce safety measures which provide the best protection for all persons involved directly with sampling and/or decontamination.

It is the responsibility of any subcontractors (i.e., drilling contractors) to follow the proper, designated decontamination procedures that are stated in their contracts and outlined in the Project Health and Safety Plan.

It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and to ensure that any contaminants are not negligently introduced to the environment.

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3.0 Supporting Materials

- cleaning liquids: soap and/or detergent solutions, tap water, deionized water, methanol
- personal safety gear (defined in Project Health and Safety Plan)
- chemical-free paper towels
- disposable gloves
- waste storage containers: drums, boxes, plastic bags
- cleaning containers: plastic buckets, galvanized steel pans
- cleaning brushes

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4.0 Methods or Protocol for Decontamination

4.1 General Procedures

4.1.1 The extent of known contamination will determine to what extent the equipment needs to be decontaminated. If the extent of contamination cannot be readily determined, cleaning should be done according to the assumption that the equipment is highly contaminated until enough data are available to allow assessment of the actual level of contamination.

4.1.2 Adequate supplies of all materials must be kept on hand. This includes all rinsing liquids and other materials listed in Section 3.0.

4.1.3 The standard procedures listed in the following section can be considered the procedure for full field decontamination. If different or more elaborate procedures are required for a specific project, they will be spelled out in the project work plan. Such variations in decontamination may include following all, just part, or an expanded scope of the decontamination procedure stated herein.

4.2 Standard Procedures

4.2.1 Remove any solid particles from the equipment or material by brushing and then rinsing with available tap water. This initial step is performed to remove gross contamination.

4.2.2 Wash equipment sampler with the soap or detergent solution.

4.2.3 Rinse with tap water

4.2.4 Rinse with deionized water

4.2.5 Rinse with methanol

4.2.6 Repeat entire procedure or any parts of the procedure if necessary

4.2.7 Allow the equipment or material to air dry before re-using

4.2.8 Dispose of any soiled materials in the designated disposal container

5.0 Specific Decontamination Procedures

5.1 Submersible Pump

5.1.1 Applicability

This procedure will be used to decontaminate submersible pumps between ground-water sample collection points and at the end of each day of use.

5.1.2 Materials

- o plastic-nalgene upright cylinder
- o 5-10 gallon plastic water storage containers
- o methanol and dispenser bottle
- o deionized water and dispenser bottle
- o chemical free paper towels

5.1.3.1 During decontamination the submersible pump will be placed on a clean surface or held away from ground.

5.1.3.2 When removing the submersible pump from each well the power cord and discharge line will be wiped dry using chemical-free disposable towels.

5.1.3.3 Clean the upright plastic-nalgene cylinder with first a methanol and then a deionized water rinse, wiping the free liquids after each.

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5.1.3.4 Reverse pump backwashing all removable residual water present in the pump tubing. The pump should be shut off as soon as intermittent flow is observed from the reverse discharge.

5.1.3.5 Rinse the stainless steel submersible down hole pump section with a liberal application of methanol and wipe dry.

5.1.3.6 Place the submersible pump section upright in the cylinder and fill the cylinder with tap water, adding 50-100 ml of methanol for every one liter of water.

5.1.3.7 Activate the pump in the forward mode withdrawing water from the cylinder.

5.1.3.8 Continue pumping until the water in the cylinder is pumped down and air is drawn through the pump. At this time air pockets will be observed in the discharge line. Shut off the pump immediately.

5.1.3.9 Remove the pump from the cylinder and place the pump in the reverse mode allowing that all removable water be discharged on to the ground surface as discussed in Step 4

5.1.3.10 Using the water remaining in the cylinder, rinse the sealed portion of the power chord and discharge tube by pouring the water carefully over the coiled lines.

5.1.3.11 When reaching the next monitoring well place the pump in the well casing and wipe dry both the power and discharge lines with a clean paper towel as the pump is lowered.

5.1.4 Quality Assurance

To assure that decontamination is complete, field blank samples shall be collected using the cleaned submersible pump. These field blanks will be subsequently analyzed for the parameters of interest with respect to the ground water.

The procedure for collecting the field blanks will comprise using the pump to withdraw the tap water used for decontamination, from the plastic cylinder to sample containers. This field blank sample collection procedure shall only be performed after the materials to be used have been decontaminated.

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STANDARD OPERATING PROCEDURE

Title: Borehole Pressure Testing

Date: 1st Qtr 198
Number: 7710
Revision: 0

1.0 General Applicability

This SOP describes the methods used for conducting water-pressure tests in drilled boreholes. The purpose for conducting water-pressure tests is to determine the permeability of the bedrock within a borehole. The portion of the borehole to be tested is sealed off with inflatable packers which expand to the walls of the borehole to prohibit movement of water past the packer. Theoretically, the seal allows water pumped into the test zone between the packers to escape only to the available joints and intersticies within the rock. If only one packer is used, the zone tested is the area directly beneath it.

2.0 Responsibilities

Water-pressure testing is generally conducted during an active boring program, therefore it is generally the responsibility of the contract driller to provide the necessary equipment for conducting the tests. It is the responsibility of the geologist or engineer to ensure that the tests are performed according to the requisites of this SOP, and to record any deviations from the SOP.

In addition, it is the responsibility of geologist or engineer to determine the zones of the borehole to be tested and the duration of the tests. All testing parameters and results are to be recorded by the geologist or engineer on the appropriate forms or field book.

3.0 Supporting Materials

3.1 Pneumatic Packers

Pneumatic packers consist of metal and rubber cylinders whose central rubber portions are a minimum of 12 inches in length and are pneumatically inflatable to seal off a zone of the borehole. The packers are attached together by a perforated pipe to allow water to escape into the test zone. A single packer may be used for testing of the entire hole, the bottom portion of the hole, or when testing is done in sections during the progress of the drilling.

3.2 Water-Flow Meter

Measures water flow in gallons. This meter shall be easily readable and calibrated to an accuracy within 1.5% (i.e., 0.75 gallons over 50 gallons). The units of graduation shall not exceed 1 gallon.

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3.3 Water-Pressure Gauge

Measures water pressure in pounds per square inch (psi). This gauge shall be easily readable and calibrated to an accuracy of ±2.5 psi. The units of graduation shall not exceed 5 psi.

3.4 Surge Chamber (optional)

A heavy, metal, air-filled cylinder installed to prevent the pulsating water delivery yielded by some pumps. The surge chamber should be capable of withstanding the maximum water pressure.

3.5 Flow Valve (optional)

Controls flow from the pump into the test system and water pressure as shown on the water-pressure gauge.

3.6 Bypass Valve

Permits bypassing any desired portion of the flow back into the pump.

3.7 Nitrogen Tank or Compressed Air

Nitrogen or compressed air shall be used to inflate the pneumatic packers because of their nonflammable character. The tank should be equipped with a pressure regulator and gauges. Two gauges on top show the amount of gas left in the tank in psi and amount of pressure deployed to the packers (packer pressure). The packer pressure gauge shall be scaled in increments not to exceed 20 psi. These gauges do not require calibration by an independent laboratory. Stock gauges will be satisfactory.

3.8 Minimum Nominal 3/4-inch I.D. Pipe

Used to lower the packer assembly to the appropriate depth and transport water down to the test zone.

3.9 Air Hose

The air hose shall be made of materials capable of withstanding twice the allowable net pressure of the pneumatic packers.

3.10 Pump

A positive displacement or Moyno pump having a minimum capacity of 20 gpm at a pressure of 100 psi. should be used.

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STANDARD OPERATING PROCEDURE

Title: Borehole Pressure Testing

Date: 1st Qtr 198
Number: 7710
Revision: 0

4.0 Method or Protocol for Conducting Test

4.1 General Procedure

4.1.1 The depth, interval, duration of testing and frequency of readings will be decided by the geologist or engineer or his supervisor prior to testing. Any changes in the standard procedures must be authorized by the geologist or engineer.

4.1.2 The equipment shall be set up as shown in the attached form or in any other approved way so that ease of operation and facility in taking readings is maintained throughout the duration of the test. The water-flow meter should be tested prior to use by running a known volume through the meter and checking its calibration.

4.1.3 The boring shall be flushed out to remove cuttings and drilling mud (if used) prior to insertion of the packer assembly.

4.1.4 Prior to testing, several measurements need to be taken and documented. These include:

- length of zone tested;
- length of packer, rubber portion only;
- length of portion of hole not tested if double packer assembly is used;
- length of entire assembly;
- elevation difference between water pressure gauge and stabilized ground water table within the borehole. (The water table should be allowed to stabilize for 24 hours prior to testing when practical.)
- length of hose or piping used in each test.

4.1.5 The water test pressure (P_w) will be selected by the geologist or engineer and will be less than the maximum water pressure (P_w max). P_w max shall be 10 psi plus 1 psi per foot of depth to the top of the test zone and shall be recorded on the test form.

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4.1.6 The packer pressure will be selected by the geologist or engineer. The approximate packer pressure can be determined as follows:

P_p = packer pressure = inflation (resistance of rubber) pressure in air + 1/2 of hydrostatic head on the packer (approximate static water pressure) + 1.2 P_w max.

The packer pressure shall not exceed the design pressure of the packer. The nitrogen or compressed air tank shall be set at the selected packer pressure and the pressure recorded on the form given.

The water pressure testing shall be carried out as determined by ERT. A four-phase test is outlined as follows:

Test Pressure	Packer Pressure
Phase 1 (1/2) P_w	P_p
Phase 2 P_w	P_p
Phase 3 P_w	P_p plus 20 psi

If the measured flow in Phase 3 is less than that in Phase 2, then:

Test Pressure	Packer Pressure
Phase 4 (1/2) P_w	P_p plus 20 psi

If there is no water taken in during Phase 2, the geologist or engineer may end the test.

The third phase is a check on the second phase to determine whether leakage past the packer has occurred. Increase of packer pressure of 20 psi is often sufficient, but higher increases may be used as the situation dictates.

4.2 Standard Procedure

4.2.1 Insert packer assembly into cleaned borehole to the required depth and inflate.

4.2.2 Begin water flow at the appropriate pressure and take readings from the flow meter every 30 seconds. A minimum of 5 minutes of consistent readings shall be taken for each phase.

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4.2.3 The geologist or engineer may end the test if the following occurs:

- In the event that a zone will not take water in the first 3 minutes of testing.
- In the event that a zone will not hold a water test pressure of (1/2) P_w.
- In the event that the measured flow in Phase 3 is greater than that in Phase 2 (i.e., hydraulic jacking of the rock).

4.2.4 All readings and other pertinent test data shall be recorded on the included form.

4.2.5 Perform general maintenance and decontamination as needed. It is the responsibility of the geologist or engineer to ensure that these procedures are carried out satisfactorily

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5.0 Documentation

A <u>pressure-test report</u> shall be completed by the subcontractor or geologist or engineer, or both, for each test conducted. This includes all measurements taken prior to the test as well as all test results.

A <u>field log</u> shall also be kept to list of all tests performed and their locations.

All documentation shall be maintained in the project files following completion of the project.